

TEXAS AGRICULTURAL EXPERIMENT STATION

A. B. CONNER, DIRECTOR,
College Station, Texas



FIFTY-SECOND ANNUAL REPORT
1939



AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
T. O. WALTON, President

Staff

TEXAS AGRICULTURAL EXPERIMENT STATION
Agricultural and Mechanical College of Texas

May 1, 1940

MAIN STATION

Administration:

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Velma Graham, Analyst

Horticulture:

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W. S. Flory, Ph. D., Horticulturist

Range Animal Husbandry:

J. M. Jones, A. M., Chief
B. L. Warwick, Ph. D., Geneticist
J. H. Jones, B. S., Animal Husbandman
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Entomology:

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H. J. Reinhard, B. S., Entomologist
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S. E. Jones, Ph. D., Entomologist
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Plant Pathology and Physiology:

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G. E. Altstatt, M. S., Plant Pathologist
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P. H. Czarowitz, B. A., Asst., Farm Mgt.
*Joe Mothral, B. S., Coop. Agt. B. A. E.
*J. W. Huckabee, B. S., Coop. Agt. B. A. E.

Rural Home Research:

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Sylvia Cover, Ph. D., Food Specialist

Soil Survey:

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*E. G. Fitzpatrick, B. S., Soil Scientist
*E. H. Templin, B. S., Soil Surveyor
I. C. Mowery, B. S., Soil Surveyor
Ambrose L. Nabors, M. S., Soil Surveyor
*H. M. Smith, B. S., Asst. Soil Surveyor

Swine Husbandry:

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C. W. McMath, M. S., Swine Nutritionist

Dairy Husbandry:

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F. E. Hanson, M. S., Assoc., Dairy Mfg.

Poultry Husbandry:

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J. R. Couch, M. S., Poultry Husbandman
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M. H. Byrom, M. S., Agricultural Eng.

Wildlife Research:

**W. P. Taylor, Ph. D., Chief

Main Station Farm:

J. E. Roberts, B. S., Superintendent

* In cooperation with United States Department of Agriculture.

** In cooperation with United States Department of Interior.

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H. B. Parks, B. S., Chief
A. H. Alex, B. S., Queen Breeder

Feed Control Service:

F. D. Fuller, M. S., Chief
James Sullivan, Assistant Chief
S. D. Pearce, Secretary

J. H. Rogers, Feed Inspector
K. L. Kirkland, B. S., Feed Inspector
S. D. Reynolds, Jr., Feed Inspector
P. A. Moore, Feed Inspector
E. J. Wilson, B. S., Feed Inspector
H. G. Wickes, D. V. M., Feed Inspector
J. K. Francklow, Feed Inspector
R. A. Turck, Feed Inspector

Members of Teaching Staff Carrying Cooperative Projects on the Station

S. W. Bilsing, Ph. D., Entomology	A. L. Darnell, M. A., Dairy Husbandry
C. E. Murphey, M. S., Animal Husbandry	V. A. Little, M. S., Entomology
R. G. Reeves, Ph. D., Biology	P. B. Pearson, Ph. D., Animal Husbandry
J. H. Quisenberry, Ph. D., Genetics	P. J. Talley, Ph. D., Biology
F. R. Brison, M. S., Horticulture	W. B. Davis, Ph. D., Wildlife
C. N. Shepardson, M. S., Dairy Husbandry	A. K. Mackey, M. S., Animal Husbandry

SUBSTATIONS

No. 1, Beeville, Bee County:

R. A. Hall, B. S., Superintendent
E. M. Neal, B. S., Animal Husbandman

No. 2, Tyler, Smith County:

*P. R. Johnson, M. S., Superintendent
J. C. Ratsek, Ph. D., Hort., Rose Inv.
E. W. Lyle, Ph. D., Plant Path., Rose Disease Investigations
*J. B. Pope, M. S., Project Leader, S. C. S.
*O. C. Word, B. C. E., Agrl. Engineer, S. C. S.

No. 3, Angleton, Brazoria County:

R. H. Stansel, M. S., Superintendent
H. M. Reed, B. S., Horticulturist
P. L. Piercy, D. V. M., Animal Path.
J. J. Reid, D. V. M., Animal Path.
C. A. Woodhouse, D. V. M., M. S., Parasitologist
*O. W. Olsen, Ph. D., Asst. Parasitologist

No. 4, Beaumont, Jefferson County:

R. H. Wyche, B. S., Superintendent
Chas. E. Minarik, Ph. D., Plant Physiologist
*H. M. Beachell, M. S., Asst. Agronomist

No. 5, Temple, Bell County:

*C. H. McDowell, M. S., Superintendent
C. H. Rogers, Ph. D., Plant Pathologist
*H. O. Hill, B. S., Project Supervisor, S. C. S.

No. 6, Denton, Denton County:

P. B. Dunkle, M. S., Superintendent
*I. M. Atkins, Assoc. Agronomist

No. 7, Spur, Dickens County:

*R. E. Dickson, B. S., Superintendent
*B. C. Langley, M. S., Agronomist
*C. E. Fisher, M. S., Asst. Soil Cons.
*J. K. Riggs, B. S., Agt. in Nutr. Invest.

No. 8, Lubbock, Lubbock County:

D. L. Jones, Superintendent
Frank Gaines, Irrigationist

No. 9, Balmorhea, Reeves County:

J. J. Bayles, B. S., Superintendent

No. 10, College Station, Brazos County:

R. M. Sherwood, M. S., In charge
L. J. McCall, Farm Superintendent

No. 11, Nacogdoches, Nacogdoches County:

H. F. Morris, M. S., Superintendent

No. 12, Chillicothe, Hardeman County:

*J. Roy Quinby, M. S., Superintendent
*J. C. Stephens, M. S., Assoc. Agronomist

No. 14, Sonora, Sutton-Edwards Counties:

W. H. Dameron, B. S., Superintendent
I. B. Boughton, D. V. M., Veterinarian
W. T. Hardy, D. V. M., Veterinarian
V. L. Cory, M. S., Range Botanist
*O. G. Babcock, B. S., Asst. Entomologist
O. L. Carpenter, Breeding Supervisor

No. 15, Weslaco, Hidalgo County:

W. H. Friend, B. S., Superintendent
J. F. Wood, B. S., Horticulturist
G. H. Godfrey, Ph. D., Plant Pathologist
P. T. Riherd, M. S., Entomologist
*J. L. Heid, B. S., Chemist

No. 16, Iowa Park, Wichita County:

L. E. Brooks, B. S., Superintendent
B. S. Pickett, Ph. D., Horticulturist

No. 19, Winter Haven, Dimmit County:

E. Mortensen, B. S., Superintendent
*L. R. Hawthorn, B. S., Horticulturist
S. S. Ivanoff, Ph. D., Plant Pathologist

FIELD LABORATORIES

Apicultural Research Laboratory, San Antonio:

H. B. Parks, B. S., Apiculturist, in charge
A. H. Alex, B. S., Queen Breeder

East Texas Pasture Investigations Laboratory, Rt. 1, Lufkin:

E. K. Crouch, B. S., Agronomist, in charge

Truck Crop Insect Investigations Laboratory, Dickinson:

**J. N. Roney, M. S., Entom., in charge

Loco Weed Research Laboratory, Alpine:

*Frank P. Matthews, Ph. D., D. V. M., Veterinarian

Tomato Disease Laboratory, Jacksonville:

P. A. Young, Ph. D., Plant Path. in charge

Tomato Disease Laboratory, Yoakum:

A. L. Harrison, Ph. D., Plant Path. in chg.

Sweet Potato Investigations Laboratory, Gilmer:

R. E. Wright, M. S., Hort., in chg.

Fruit Investigations Laboratory, Montague:

U. A. Randolph, B. S., Hort., in chg.

Cotton Insect Laboratory, Presidio:

*A. J. Chapman, B. S., Assoc. Entom., in chg.

*Livestock Feeding Investigations Laboratory, Big Springs:

*Fred E. Keating, B. S., Assoc. Agron. in chg.

*Jot Smyth, Jr., Agt. in An. Husb.

* In cooperation with United States Department of Agriculture.

** On leave of absence 1939-40.



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FIFTY-SECOND ANNUAL REPORT, 1939

A. B. Conner, Director

The Texas Agricultural Experiment Station is the organized agricultural research agency of the State of Texas. It is one of the major divisions of the Agricultural and Mechanical College of Texas. Its work at the Main Station is supplemented by work in field areas at sixteen substations and ten field laboratories. In addition, work is under way at other points in cooperation with other State institutions.

The work of the Agricultural Experiment Station is concerned with the development of the State's agricultural resources and opportunities. The fact that agriculture is faced with changing conditions, particularly at this time, requires an ever increasing knowledge of the resources about us and of means of augmenting, developing, and conserving these resources so that they may yield the greatest returns and opportunities for the people.

Money spent for agricultural research must be regarded as an investment which in the end will open up new opportunities, new enterprises, and enable adjustments which affect not only those engaged in agriculture but as well the opportunities for industrial development. In fact, much of the industrial development, particularly in the field of processing agricultural products, is directly dependent upon the kind and quality of raw products produced and the extent to which these products can be made available in quantities sufficient to permit of successful and profitable processing.

Agriculture at the present time is encountering revolutionary changes which require a full measure of facts and information so that its reorganization can be based upon sound principles. For this reason there is great need for stimulating and developing agricultural research work that it may serve in the fullest way the reorganization of agriculture on a sound and substantial basis. Such a condition of agriculture is vital to our national welfare and to national defense as well as imperative to the welfare of the people engaged in it. A well developed and well organized agriculture can provide the best means of meeting strenuous competition which we are likely to face both within and outside the borders of the nation. Agriculture supplies raw materials and products for feeding and clothing the people of the nation and a well organized agriculture can consistently expect to share in furnishing feed and clothing to the people of other parts of the world. These things can be accomplished in no other way than through basing our organization and development upon sound facts and information, much of which can be established only through research.

There are many specific examples in which the work of the Agricultural Experiment Station has had a profound influence upon the development

and utilization of our resources. Research has developed and introduced the grain sorghums and in Texas the annual production is approximately 60,000,000 bushels. Methods have been developed for extending the use of this crop into the eastern areas of the State where formerly grain sorghums were not grown. There has been an increased knowledge and understanding of the cotton plant, its ability to resist drouth, its fruiting habits and its characteristics, all of which have to be taken into account in growing the crop. In fact under conditions where insect and plant disease depredations occur, these factors are vital to the successful control of these pests. New methods of treating and controlling animal diseases have been developed and are in general use, of which the soremouth vaccine is an example. Much information has been developed in practical methods of conserving soil and water resources of the land, and this information is being used now in a national soil and water conservation program. Research has developed additional new crops, such as Honey June and Surcopper Sugar sweet corns adapted to Texas conditions. It has developed high producing yellow corns, now in general use in the State. Research has found strains of wheat and oats resistant to stem and leaf rust, which will make possible the utilization of small grain for grazing purposes and for the production of grain and hay in many sections of the State where the crop previously could not be grown because of stem and leaf rust. Research has developed a knowledge of the principal soil regions of the State, the composition of these soils, and the most important chemical elements contained. Research has developed much basic information as to the best means of utilizing the resources and opportunities of the land in the several different regions and this information is of direct value to those engaged in or interested in agricultural welfare.

The Texas Agricultural Experiment Station is also a source of information to the several institutions engaged in the teaching of agriculture. It serves in a definite way the Extension Service in the application of reliable facts and information. It likewise furnishes to vocational teachers reliable information for teaching. The results of research are published and distributed to farmers, ranchmen, and to other interested individuals, and to libraries and agencies engaged in the dissemination of agricultural information.

The following report shows the organization of this agency, some of the facilities for research, and the progress made during the year in solving or alleviating some of the more urgent agricultural problems.

ORGANIZATION AND WORK

The Agricultural Experiment Station System comprises the Main Station with twenty divisions at College Station, sixteen substations in the several agricultural regions of the State, and ten field laboratories, as follows:

Divisions

Administrative	Botany
Veterinary Science	Swine Husbandry
Chemistry	Dairy Husbandry
Horticulture	Poultry Husbandry
Range Animal Husbandry	Rural Home Research
Entomology	Apiculture
Agronomy	Feed Control Service
Plant Pathology and Physiology	Agricultural Engineering
Farm and Ranch Economics	Wildlife Research
Soil Survey	Publications

Substations

No. 1, Beeville, Bee County	No. 11, Nacogdoches, Nacogdoches County
*No. 2, Tyler, Smith County	*No. 12, Chillicothe, Hardeman County
*No. 3, Angleton, Brazoria County	*No. 14, Sonora, Sutton-Edwards Counties
*No. 4, Beaumont, Jefferson County	No. 15, Weslaco, Hidalgo County
*No. 5, Temple, Bell County	No. 16, Iowa Park, Wichita County
*No. 6, Denton, Denton County	*No. 19, Winter Haven, Dimmit County
*No. 7, Spur, Dickens County	
No. 8, Lubbock, Lubbock County	
No. 9, Balmorhea, Reeves County	
No. 10, College Station, Brazos County	

Field Laboratories

- *Apiculture Research Laboratory, San Antonio, Bexar County.
- Truck Crop Insect Investigations Laboratory, Dickinson, Galveston County.
- *Cotton Insect Laboratory, Presidio County.
- *Loco Weed Laboratory, Alpine, Brewster County.
- East Texas Pasture Investigations Laboratory, Lufkin, Angelina County.
- Tomato Disease Laboratory, Jacksonville, Cherokee County.
- Tomato Disease Laboratory, Yoakum, Lavaca County.
- *Sweet Potato Laboratory, Gilmer, Upshur County.
- Fruit Investigations Laboratory, Montague, Montague County.
- *Livestock Feeding Investigations Laboratory, Big Spring.

Facilities for Research

The Texas Agricultural Experiment Station occupies and uses for research purposes a total of 11,941.03 acres of land. These lands are located in different agricultural regions of the State, and enable the Station to conduct research on problems peculiar to these regions. There is need for enlarging some of the areas to facilitate the conduct of research on important problems not now included in the program.

Office and laboratory space at the Main Station has not been enlarged, except for temporarily occupied space, since the erection of the Research

*In cooperation with the United States Department of Agriculture.

Administration Building in 1918. When one considers the fact that the staff of technical workers at the Main Station has increased from about 30 in 1918 to more than 100 at the present time, it is not difficult to realize the acute need for expansion in laboratory and office space.

The agricultural research library, a unit of the Main Library of the Agricultural and Mechanical College of Texas, is being improved and considerable progress has been made in making available to research workers material, particularly periodical sets, not hitherto available except on interlibrary loan. The Agricultural Experiment Station for the past two years has expended approximately \$20,000 for acquisitions and binding, but the library facilities need to be greatly extended before research workers and others at this Institution have full information on progress in research in other states and nations necessary in planning the conduct of research to avoid duplication of effort and to expend most efficiently funds available for research.

The S. M. Tracy Herbarium has been transferred to the Museum building and has been greatly extended during the last few years. It now has a collection of approximately 50,000 mounted specimens, mostly native flora of Texas. In the collection only 849 foreign plants are included. The Helge Ness collection of mounted plants as well as the collections of Cory and Parks have been added to the Herbarium, which embraces 1,063 genera and 5,099 species. During the year a collection by Simon Wolff has been added and a smaller but highly valuable collection from McKittrick Canyon, Guadalupe Mountains, has been presented by W. B. Davis and others in the Department of Wild Game of the College. The facilities of the Herbarium are available not only to research workers and members of the teaching staff but also to students and others interested in the flora of the Southwest.

VETERINARY SCIENCE

Loin Disease in Cattle

Studies of loin disease are being continued. During the past year progress in the purification of cultures has been made insofar as a number of contaminating organisms have been eliminated.

H. Schmidt.

Infectious Bovine Abortion

(In cooperation with School of Agriculture, A. & M. College of Texas.)

The dairy herd of the Feeding and Breeding Station and the dairy herd of the A. & M. College have apparently been freed of Bang's disease or infectious bovine abortion. In the dairy herd of the Feeding and Breeding Station this was accomplished by removing heifer calves at five months of age from the infected premises and raising them to maturity on clean premises. In the dairy herd of the A. & M. College another method was used. In this herd periodic blood testing was practiced and the reactors

eliminated. Blood testing is being continued in this herd to safeguard against any possible recurrence of the disease which might take its origin from a still undetected carrier.

H. Schmidt, R. D. Turk, O. C. Copeland, C. N. Shepardson.

Trichomonad Abortion of Cattle

(In cooperation with School of Agriculture, A. & M. College of Texas.)

The outbreak of this disease in the A. & M. College dairy herd has apparently been completely stopped. No additional positive cases have been discovered in the last two years. Our work during the first outbreak therefore has yielded very gratifying results.

H. Schmidt, R. D. Turk, C. N. Shepardson.

Effect of Moldy Feed on Sheep and Other Farm Animals

Work on this project has been interrupted on account of lack of material from the field. No case reports were received during the year and no new material was available.

H. Schmidt.

Swamp Fever in Horses and Mules

Work on this project has been suspended on account of lack of material but will be resumed when conditions and facilities permit.

H. Schmidt.

Loco Weed Poisoning

(In cooperation with Bureau of Animal Industry, U. S. D. A.)

No additional field experiments were conducted during the year because suitable areas where loco was prevalent enough for such work were not available.

Frank P. Mathews.

Jimmies in Sheep and Goats

(In cooperation with Bureau of Animal Industry, U. S. D. A.)

Experiments on this condition were planned and executed and a number of sheep carried to the point of coming down with jimmies during the year when rains came and brought on fresh green grass which stopped the disease. A new area where this trouble occurs has been found.

Frank P. Mathews.

Poisonous Plants in the Davis Mountains

(In cooperation with Bureau of Animal Industry, U. S. D. A.)

Red-stemmed Peavine (*Astragalus emoryanus*) Poisoning.—A manuscript on red-stemmed peavine has been prepared and is in the process of publication.

Sacahuista Poisoning.—A bulletin has been prepared and edited for publication on sacahuista poisoning.

Sartwellia flaveriae.—Work on this plant has been continued. A manuscript is in the process of being prepared for publication.

Drymaria pachyphylla.—A new location has been found where this plant occurs and where it has caused some losses among cattle. Proper warning has been given.

Frank P. Mathews.

Processing of Canned Meat

A progress report on this project will be summarized by the Division of Rural Home Research.

H. Schmidt, R. D. Turk, Sylvia Cover.

Disease Resistance in Animals

Progress of this project will be reported from the Division of Range Animal Husbandry.

H. Schmidt, R. D. Turk, B. L. Warwick, R. O. Berry.

Pathological Conditions Accompanying Vitamin Deficiencies

A change of workers on this project during the year has occasioned some delay, but the material that had been collected is being worked up as fast as possible. Progress has been made insofar as some of this material has been worked up to the point for final microscopic examination.

The steer that had been brought to College Station from the 1936-1937 experiment at Spur, and which was still living at the last annual report, was sacrificed the latter part of November in a state of uremic acid poisoning due to complete occlusion of the urethra with urinary calculi. This condition is giving us much trouble with our experimental animals on this project and an experiment has been designed and started to throw some light on the possible connection between vitamin A deficiency and urinary calculi.

H. Schmidt, H. A. Smith.

Anaplasmosis in Cattle

Experiments with different species of biting flies in attempts to transmit the disease in the field have again been tried during the last fly season. No transmissions were obtained in these experiments. A number of ticks were also used in attempts to transmit it, likewise with negative results.

At the end of the fly season the work with anaplasmosis was moved to the new Animal Disease Laboratory at Substation No. 3, Angleton, Texas.

P. L. Piercy.

Serum Calcium and Inorganic Phosphorus of Sheep

This project is being carried on at Texas Substation No. 14, Sonora, and is reported upon at that point.

H. Schmidt.

The Role of Nicotinic Acid in the Nutrition of Ruminants

(In cooperation with School of Agriculture, A. & M. College of Texas.)

One series of observations has been completed with the result that sheep on a diet very low in nicotinic acid carried the same blood level of nicotinic acid and excreted practically the same amount daily in the urine as sheep on a normal ration.

P. B. Pearson, H. Schmidt, A. K. Mackey.

Testing Manufactured Feed Samples for Poisons or Other Substances

During the year a new project was undertaken to test manufactured feed samples for poisons or other harmful substances. Up to this time only one sample has been tested with negative results.

H. Schmidt, F. D. Fuller.

Mastitis Investigation

(In cooperation with School of Agriculture, A. & M. College of Texas.)

In recent years a new drug has been discovered that gives much promise as a cure for mastitis in cows.

During the year a project on mastitis investigation was undertaken in the A. & M. College dairy herd with a view of detecting latent mastitis infections and determining the effect of treatment with this drug. Work has not advanced far enough to render a report.

H. Schmidt, R. D. Turk, A. L. Darnell.

Investigation of Gastrointestinal Parasites in Cattle

During the year a project on the investigation of gastrointestinal parasites in cattle was inaugurated at the new Animal Disease Laboratory at Substation No. 3, Angleton, Texas. At this time no progress report can be made.

C. A. Woodhouse, J. J. Reid, H. Schmidt.

Investigation of Toxemia in Cattle

During the year a project for the study of toxemia among cattle in the Gulf Coast Area of Texas was inaugurated at the new Animal Disease Laboratory at Substation No. 3, Angleton, Texas. At this time no progress report can be made.

J. J. Reid and H. Schmidt.

CHEMISTRY

Factors of Soil Fertility

Greenhouse experiments with corn have shown that there are great differences in the availability of the potash in different soils, and that corn can secure relatively large amounts of potash from the acid-soluble, non-active compounds in some soils. This work will appear in Volume 4 of the Proceedings of the Soil Science Society of America (1939). Similar experiments have shown that there are differences in the availability of phosphoric acid in different soils. Other factors have been studied.

G. S. Fraps, J. F. Fudge, and P. F. Macy.

Soils

The results of chemical analyses of soils of Cass, Dickens, Falls, Harde-man, Polk, Scurry, and Wheeler Counties will appear as Bulletin 581. Similar work on soils of a number of other counties is being conducted.

G. S. Fraps and J. F. Fudge.

Nitrification

Phosphates have increased nitrification of ammonium sulphate on some soils of low nitrifying capacity. These results have been published in Soil Science.

While acid soils decompose nitrites, such loss is not likely to occur during the process of nitrification in soils. These results have been published in Soil Science.

The depressing effect on nitrification of organic substances, such as starch, cane sugar, cocoa shells, pecan hulls, grapefruit peelings and Wesson oil is being studied. The depressing effect is quite persistent, even after 12 weeks incubation.

Sulphur in some cases has a depressing effect on nitrification.

The nitrification of calcium cyanamid and its decomposition products such as dicyandiamide, guanidine, guanilurea, and urea is being studied. Dicyandiamide is not readily nitrified, guanidine and guanilurea slightly nitrified, and urea readily nitrified, almost as well as ammonium sulfate.

The number of nitrifying and other organisms as related to nitrification is being studied.

A. J. Sterges.

Cotton Root Rot

While acid soils inhibit the growth of cotton root rot, the hydrogen ions are not directly toxic to the organisms. Zinc may possibly be toxic to cotton root rot in very small concentrations. The rate of oxidation of sulphur in the soil to form sulphuric acid depends upon the fineness of the sulphur.

The Relation of Soil Composition to Plant and Animal Deficiencies

The study of the relation of the chemical composition of soils to plant and animal deficiencies has been continued. Particular attention was given to the phosphoric acid, protein, and lime contents of the forage. During the year, 935 samples of forage have been collected in Northwest Texas.

A paper discussing the relations between the protein, phosphoric acid, and lime contents of young Bermuda and young and mature little bluestem grasses, and the nitrogen, active phosphoric acid, and active lime in the soils on which they grew has been published in the Proceedings of the Soil Science Society of America.

Results of the analyses of 1,432 samples of forage and 80 samples of soil collected in the East Texas Timber Country have been prepared for publication as a bulletin. Similar publications for the Gulf Coast Prairie and the Rio Grande Plain will be prepared.

About 400 samples of various species of forage have been received from various Substations and Divisions of the Station for analysis in connection with studies of various factors affecting the chemical composition of forage.

A study of fluorine in various Texas grasses, feeds, and products is being carried on.

J. F. Fudge.

Loco Weed

Further experiments have been carried out on the loco weed in an effort to isolate the toxic principle in it. The purest fraction obtained in previous work here has been studied by means of extraction with iso-amyl alcohol and with phenol at different pH values; by absorption with fuller's earth and aluminum oxide under specific conditions; and by attempted preparation of such crystalline derivatives as the picrate, flavianate, reineckate, tartrate, and dinitrobenzoate. Crystalline substances have been obtained after treatment with flavianic acid and with picric acid. Silicotungstic acid solution divides previously obtained locoine solutions into one fraction contained in a precipitate and another containing substances not precipitated by the silicotungstic acid. On purification of the two new fractions, each yields a crystalline phosphotungstate on proper treatment with phosphotungstic acid solution. Further work is now being carried out to determine the exact status of the toxic substance after this new separation. Further study of the problem with other precipitants and solvents is also being continued.

S. H. Wender.

Productive Energy Values of Animal Feeds

The productive energy of a mixed chicken feed has been thoroughly determined and the results of the work are published in Bulletin 571. A

comparison of the productive energy of corn meal with that of wheat gray shorts, patent flour, low grade flour, and wheat bran has been published in the Journal of Nutrition. A study of the relation between the gain in weight and the gain in energy due to several rations has been accepted for publication in the Journal of Agricultural Research. Other work has been done. Work on the metabolizable energy of chicken feeds is being prepared for publication.

G. S. Fraps and E. C. Carlyle.

Productive Energy of Human Foods

Ten experiments, each experiment consisting of four different tests, were carried out during the year. The materials tested were corn meal, rice polish, rice bran, oat hulls, two varieties of kafir, wheat bran, casein, starch, Wesson oil, corn oil, soy bean oil, cotton seed meal, tankage, dried butter-milk, alfalfa leaf meal, peanut oil. These experiments involved the use of about 320 chicks.

Two experiments using young rats were made with corn meal, wheat bran, wheat gray shorts, patent flour, casein, starch and Wesson oil.

G. S. Fraps and E. C. Carlyle.

Variations in the Vitamin Content of Human Foods

The carotene content has been determined in 34 samples of canned fruits and vegetables. Spinach, mustard greens and turnip greens are high in carotene, while beans, peas, olives, pickles and pears are low in carotene. Fresh vegetables were similar in carotene to canned ones; the greens, carrots and sweet potatoes were high in carotene, while the other vegetables were low. Fresh samples of vegetables ground through a food chopper lost 50% of their carotene content in 10 minutes. This loss and means of preventing it is being studied. Some of this work is being prepared for publication.

The effect of quantity of carotene at various levels on the longevity, health and reproduction of white albino rats has been continued, but the work has not been completed. The study of the storage of vitamin A in the livers of white albino rats on various levels of carotene intake has also been continued.

The study of the relation between the chemical composition and the biological value of vitamin A potency has been made on 61 samples of Texas feeds and foods by the use of the modified U.S.P. method. A study of the vitamin A potency of various impurities extracted from the crude carotene fraction from corn and alfalfa and other foods or feeds has been started.

A paper on the estimation of vitamin D and vitamin A in fish liver oils and their concentrates will be published in the Journal of the Association of Official Agricultural Chemists.

W. W. Meinke and Ray Treichler.

Quantitative Requirements of Animals for Vitamin A

The study of the quantitative requirements of chickens, beef and dairy cattle, pigs and sheep for Vitamin A has been continued in cooperation with the Divisions of Poultry Husbandry, Dairy Husbandry, Range Animal Husbandry, Swine Husbandry, and Veterinary Science. The work with beef cattle is also in cooperation with the Bureau of Animal Industry, United States Department of Agriculture. Pure carotene determinations were made at regular intervals on the alfalfa or other feeds used in the work. Livers, butters, and blood plasma were analyzed for vitamin A and carotene. Further information on these studies will be given by various cooperating divisions. Some of this work has been published in the Proceedings of the Society of Animal Nutrition. A bulletin on the vitamin A requirements for chickens is being prepared jointly with the Division of Poultry Husbandry.

The method of selective adsorption for purifying carotene solutions, obtained in the procedure for estimating carotene has been improved. Difficulties in the preparation of suitable adsorbents which were encountered previously have been largely eliminated. Simple methods of preparing adsorbents of desired selectivity have been developed. This work has been accepted for publication in the Journal of Industrial and Engineering Chemistry. A method for the determination of carotene in the presence of lycopene, which involves the use of a highly selective adsorbent, was developed and will be published in the Journal of the Association of Official Agricultural Chemists. The impurities removed from carotene solutions by selective adsorption are being studied spectrographically and biologically with rats to determine if these impurities have any vitamin A potency. The "pure" carotene from a number of different feeds is being analyzed chromatographically and spectrographically to determine if it contains any carotene-like impurities. An improved adsorption method will be reported in a paper in preparation.

Collaborative A.O.A.C. work on method for determination of riboflavin was carried out. Samples of yeast and skim milk powder were sent to a number of laboratories in this country and were analyzed by various procedures. This work was reported at the meeting of the Association of Official Agricultural Chemists and will be published in their journal.

A. R. Kemmerer.

Vitamins in Commercial Feeds

Vitamin D was determined in 25 samples of commercial fish oils or concentrates. The results are published in Feed Control Bulletin 578. Vitamin A was also determined in some of these oils by chemical and biological methods. A number of the samples were found to be below guarantee in vitamin D and vitamin A. Work was done on the methods. Some of this work will be published in the Journal of the Association of

Official Agricultural Chemists. Other work on vitamins in commercial feeds is being planned.

G. S. Fraps.

Iodine

A summary of the work on iodine in vegetables and city waters has been published in Food Research. Results of the work on iodine in soils have been published in Texas Bulletin 579. The work on cottonseed meal and other feeds and detailed analyses of city waters and vegetables are being prepared for publication as a bulletin. Work on methods for the estimation of iodine in soils, plant materials, and waters has been accepted for publication in the Journal of the Association of Official Agricultural Chemists.

Texas foods, feeds, and waters in nearly all cases contain sufficient iodine for humans and for animals, so that there appears to be no necessity for the addition of iodine to commercial feeds or to salt. Very few soils of Texas are deficient in iodine.

G. S. Fraps and J. F. Fudge.

Analyses and Investigations of Commercial Fertilizers

The Chief of the Division is State Chemist and is in charge of the fertilizer law and is required to investigate the composition, properties and agricultural values of fertilizers or fertilizer materials or ingredients of fertilizers sold or offered for sale within the State of Texas.

One thousand two hundred and eight samples of commercial fertilizers were collected and analyzed. In general, the composition was well up to that guaranteed by the manufacturers. The results of the inspection and analyses are published in Bulletin 577, also suggestions are made for the use of commercial fertilizers. Twenty-four samples were analyzed to check upon claims of non-acid forming quality. A number of fertilizers in common use were analyzed for the lime, sulphur and manganese content. The agricultural value of phosphosilicate, a new by-product containing available phosphoric acid, is being investigated, and also non-acid forming fertilizers.

The fertilizer manufacturers agreed upon 22 grades of mixed fertilizer to be sold in Texas during season 1939-40. Fertilizer statistics of Texas for 1926 to 1938 were published in Bulletin 572. Information regarding the use of commercial fertilizers was published in Circular 85.

The report of the Chief as referee on fertilizers of the Association of Official Agricultural Chemists will be published in the Journal of the A.O.A.C.

G. S. Fraps and T. L. Ogier.

Chemical Analyses and Investigations of Commercial Feeds

The estimation of protein, fat, water, crude fiber, and ash, and the microscopic examination were made on about 3,524 samples of feed for

the Division of Feed Control. The hardness of 25 samples of cottonseed cake was tested. Calcium carbonate was determined in 244 samples and salt in 338 samples. Lime and phosphorus were determined in a number of mineral feeds. These results were published in Bulletin 578 by the Division of Feed Control. Assistance was also given in the formulation of definitions and rulings.

G. S. Fraps and T. L. Ogier.

Mineral Composition of Vegetables Grown in Representative Regions of Texas and the Relation of Varieties in Mineral Content to the Probable Nutritive Value

This is a cooperative project with the Division of Rural Home Research and the Division of Horticulture.

Work on methods of analysis for iron, phosphorus, calcium and copper has been done. Analyses for calcium and phosphorus are being made on about 50 samples of turnip greens.

G. S. Fraps.

Miscellaneous

Analyses were made on a number of irrigation waters, mineral feeds and grasses, etc. Work is being continued on the estimation of sodium in various types of feeds. Investigation work is being done on various methods in use in the analytical work, to determine factors which influence results. A number of samples were analyzed in collaboration with other stations throughout the country.

Work is being continued on testing the accuracy of the chemical glassware, apparatus and analytical weights used in the Division of Chemistry. A number of samples were analyzed for various Divisions of the station.

Respectfully submitted,

G. S. Fraps.

HORTICULTURE

Fruit Adaptability Tests

There is a growing tendency to replace the early white-fleshed varieties of peaches with varieties having a yellow flesh, with preference for a freestone for shipping. The 7 varieties ripening in May all have white flesh. There are 4 yellow freestones ripening during the first half of June, none of them very satisfactory commercially. The yellow freestones ripening during the latter half of June are Early Elberta, Fair Beauty, Golden Beauty, Golden Jubilee, June Elberta, Oriole, Rochester, Slappy and Vedette. The cold requirement of Fair Beauty makes it undesirable for central Texas. There are 9 yellow freestone varieties ripening in July before Elberta, worthy of the growers' consideration. They are Eclipse, Fisher, Halehaven, J. H. Hale, Leona, South Haven, Stark's Early Elberta, Tena and Yellow Hiley. Eclipse, a seedling of Belle, is perhaps the most attractive and has firm flesh of good quality. An account of the large

collection of varieties at Substation No. 11 near Nacogdoches will be found in the report of that station.

Studies on the cold requirements of peaches now includes work on over 40 varieties. This has been done at substations Nos. 2, 11, 16 and 19 and at the Main Station. When numbers of hours below 45° F. to which budwood is exposed in the orchard during the course of the winter season is plotted against number of days to bloom after being taken into the greenhouse, we get approximately a straight line for varieties with low or moderate cold rerequirements, but a tendency toward a level area in the middle of the curve for varieties having a higher cold requirement. A comparison of results secured with the same variety at several locations indicates that the cold requirement is conditioned to a considerable extent by winter temperatures above 50°. For example, wood blooming in from 12 to 14 days in the greenhouse is considered to have its cold needs fulfilled. This point may be reached for a particular variety after 400 hours below 45° at one point, after 800 hours at another farther north, and perhaps only after 1,200 hours at a third location still farther north. However at any single location the varieties can be arranged according to the amount of cold needed for normal bloom—a rating that appears to be fairly consistent at the different locations. Similar but less marked differences have been observed over several seasons at the same place. When the number of hours above 50° in the field are added to the number of hours above this point until blooming in the greenhouse, the total is somewhat greater earlier in the season than later, although the change is not always gradual. There is, of course, a point before which the accumulation of cold is insufficient to cause any activity. This is true of all varieties at all locations with the possible exception of Peento and a few others in the southern part of the State. Hall's Yellow, for example, scarcely loses its leaves at College Station during a mild season and may bloom in January.

S. H. Yarnell, J. F. Rosborough, J. C. Ratsek,
B. S. Pickett, and substation superintendents.

Berry Breeding

Superior seedlings of the backcross of Nessberry to dewberry and raspberry have been selected at the Main Station. In the backcross to the dewberry, type of fruit and habit of growth of the dewberry is dominant. In the other cross the plants resemble the Nessberry rather closely. The greatest variation in both groups is in the flavor of the fruit. For information on work with the commercial varieties turn to the report of Substation No. 11.

S. H. Yarnell, H. F. Morris.

Citrus

Adaptability and Breeding: Varieties of tangelos are becoming increasingly popular among consumers where they are known. They are larger

than the tangerine parent but are easier to eat out of hand than a grapefruit. While they carry something of the grapefruit flavor they lack its bitterness. Tangelos do well both at the Lower Rio Grande Valley station and at the Winter Garden station. The Webber tangelo is outstanding at the latter point. It is early, well colored, of good flavor, and is about the size of a grapefruit.

Marsh, Little River and Ruby grapefruit pollen is about 16 per cent viable, while that of Duncan and Foster approaches 90 per cent. Pollen from the different varieties of oranges ranges from 35 to 80 per cent good. The tangelo (grapefruit x tangerine) has the largest proportion of good pollen—93 per cent.

The percentage of aberrant chlorophyll seedlings of Cunningham citrange was found to be 28.1 on a seed basis and 27.2 on a nucellar embryo basis (17.1 for all seedlings). The types vary from pure albino to almost normal, including a green-stem albino, variegated and virescent groups. The common appearance of several abnormal plants from a single seed eliminates normal segregation as an explanation.

W. H. Friend, E. Mortensen, J. F. Wood, S. H. Yarnell.

Rootsocks: At the Lower Valley station seedlings of sweet orange have made good growth but appear to be uncongenial with standard scion varieties. Seedlings of Triumph grapefruit are so vigorous, girdling at the time of budding is necessary to secure normal growth of the bud. The following material grown at the Winter Garden station is listed in order of seed production: Duncan grapefruit, Changsha tangerine, Kansu orange, Carrizo citrange, Swatow orange, and Louisiana Sweet orange.

W. H. Friend, E. Mortensen.

Cultural Studies with Grapefruit: This work is being done at the Lower Rio Grande Valley Station. An account will be found in the report of that station.

W. H. Friend, J. F. Wood.

Cytological Investigations: Somatic chromosome counts of tangelo seedlings disclose a triploid (27 chromosomes) in the progeny of Thornton open pollinated and a tetraploid (36 chromosomes) in an open pollinated seedling of the Sampson tangelo. This is rather surprising since most species and varieties of Citrus have been found to be diploid with a somatic chromosome number of 18. The tangelo is an interspecific cross between grapefruit and tangerine.

S. H. Yarnell.

Adaptability of Date Varieties

(In cooperation with the Bureau of Plant Industry,
U. S. Department of Agriculture.)

The crop was not very satisfactory at the Lower Rio Grande Valley station this year in spite of a favorable season. Maktoon, Halawy and

Amir Hadj soured very little while Bedraya soured 100 per cent. Good results were obtained at the Winter Garden station in spite of some rainy weather in August. Kustaway, Hayany and Amir Hadj were outstanding. Several seedlings of Amir Hadj are showing up well, one continuing to ripen fruit without souring during the balance of the year.

J. F. Wood, E. Mortensen.

Figs

Adaptability and Breeding: The following crosses were made at Substation No. 3 during the past season: Figue d'Or, Gentile, Negro Largo and Violette de la Frette x Hamma capri, Magnolia x *Ficus carica* capri, and Gentile and Negro Largo x A Boise Jaspee. Seedlings of previous crosses have begun to fruit both at Substation No. 3 and at the Main Station.

H. M. Reed, S. H. Yarnell.

Processing Experiments: This work is being done at Substation No. 3 on the Gulf Coast. For an account of the work turn to the report of that station.

H. M. Reed.

Grapes

Adaptability and Breeding: In addition to the test of vinifera and American varieties at the Winter Garden station an extensive test of varieties of the latter type has been started at the Fruit Investigations Laboratory at Montague. Self pollinated seedlings of the following Munson varieties are being grown at the Main Station: Carman, Champanel, Cloeta, Elvicand, Lomanto, Longfellow, Mericadel, Ronaldo, R. W. Munson, Salamander and Wapanuka. Some 265 seedlings of crosses made by B. B. Gillett of Pleasanton, Texas, are under observation at Substation No. 19.

E. Mortensen, U. A. Randolph, S. H. Yarnell.

Rootstocks: No single stock that is best suited for all varieties of grapes has been found at the Winter Garden Station. For one year Mustang seedlings averaged 89 per cent survival in 10 combinations. This was the highest obtained for any stock. Rupestris, which is susceptible to cotton root rot, averaged 34 per cent survival in 20 combinations for 2 seasons. Champanel did as well in 67 combinations over 6 years, as did La Pryor in 45 combinations. Dog Ridge averaged hardly as well—28 per cent for 72 combinations over the same period. The rootstock work is being extended to the Fruit Investigations Laboratory at Montague, where Dog Ridge, Champanel, La Pryor and a local native have been grafted to Carman, Delaware and Virginia. At the end of the first season La Pryor had given 34.6 per cent satisfactory unions, the local native species 24.6, Champanel 23.3, and Dog Ridge 17.1 per cent.

E. Mortensen, U. A. Randolph.

Cultural Tests: Plantings have been made at the Fruit Investigations Laboratory, Montague, for a series of tests to include fertilizers, cover

crops, spacing, training and the field control of insects and diseases. The Carman vines made excellent growth during the past season.

U. A. Randolph.

Processing Experiments: Several blends of juice compare favorably with the commercial product. Juice of Virginia was rated very high. Juice from Texas grapes was found to have a high natural sugar content. Further information can be found in the report of Substation No. 3.

H. M. Reed, U. A. Randolph.

Peach Breeding

Seedlings of the cross Hiley x Pallas fruited at College Station this year. The sweet flavor characteristic of the Honey type was observed in only part of the seedlings, the others were very mild to mildly subacid. The cold requirements of all appear to be very moderate. All are productive white-fleshed early freestones as expected. Crosses made at Substation No. 11 include Dr. Burton x Early Elberta, Arp x Early Elberta and Arp x J. H. Hale. At Substation No. 16 the following crosses were made: Dr. Burton x Carman, Early Wheeler, Belle and J. H. Hale x Dr. Burton, and Carman x Dr. Burton, Early Wheeler and Belle.

S. H. Yarnell, H. F. Morris, B. S. Pickett.

Plum Breeding

All of the 1939 plum crosses were made at Substation No. 19. Munson, one of the most important Winter Garden varieties, continued to be the outstanding seed parent. Approximately 600 pollinations on Munson with pollen from three varieties (Wickson, Duarte, and Becky Smith) and two native species (*Prunus mexicana* and *P. texana*) resulted in many sets and 41 matured fruits and seeds. Some seed resulted from each source of pollen, although only 1 occurred from a *P. texana* pollination. On the basis of percentage of pollinations resulting in seeds Becky Smith (13%) and Wickson (9%) were decidedly the best pollen parents used on Munson. Seventy-three selfed flowers of Munson gave neither sets nor seeds. From over 600 additional pollinations in which flowers on Best's Hybrid, Bruce, Methley, Burbank, Santa Rosa, Wickson and Duarte were pollinated chiefly with pollen from Munson and *P. mexicana* only 1 seed, from Burbank x Munson, was secured. Several seedlings from previous crosses are ready for orchard placement.

W. S. Flory, E. Mortensen.

Strawberry Adaptability and Breeding

Information has been secured on crosses between selections secured from earlier breeding work at the Winter Garden station. T 68 was used as the pollen parent in all cases. The deep red color of T 68 shows up well in these new seedlings. Most of the 3,300 seedlings stand the heat well. Observation is being continued on 277 selections of the 1938 crosses.

E. Mortensen.

Truck Crop Adaptability Tests

Accounts of work along this line will be found with the reports of Substations No. 15, No. 16 and No. 19.

L. R. Hawthorn, W. H. Friend, J. F. Wood, B. S. Pickett.

Vegetable Variety Descriptions

(In cooperation with the Bureau of Plant Industry,
U. S. Department of Agriculture)

This work on varieties of eggplant and peppers was continued at the Winter Garden station during the past season.

L. R. Hawthorn.

Breeding Cabbage and Related Plants

In a study of the seeding of cabbage, stumps of plants grown at Substation No. 15 and set immediately in the field at College Station were all dead by July 25. Other stumps held at 41° F. for 2 months before placing in the field received a similar fate. A third group of 26 plants stored as before and then placed on April 5 in a lighted constant temperature room where the temperature was raised over a period of 10 days from 50° to 70°, at which point it remained constant, all leafed out well. Half were dead by May 19 when the remainder were transferred to a lath house for the summer. Nine plants were alive to set in the field in October.

A cooperative study with J. C. Walker, of the Bureau of Plant Industry and the University of Wisconsin, has been made on the effects of different environments on head shape in Marion Market (yellows-resistant) cabbage. Plants from seed secured from 10 sources, have been grown for one season at each of the following places: Madison, Wisconsin; College Station, Texas; and Weslaco, Texas. Length/width ratios computed for the different lots at each of the three points indicate that Marion Market is essentially a spherical headed cabbage at Madison but heads apparently become increasingly elongated at lower latitudes. An analysis of variance comparison shows that the elongations apparent at College Station and at Weslaco, over the Madison plants, are highly significant. A consideration of the environmental factors of humidity, available moisture, temperature, clear and cloudy days, and photoperiod—all of which varied with the locations, shows that the most definite difference between the environments was that of day-lengths which roughly averaged 11 hours at Weslaco, 13 hours at College Station, and 15 hours at Madison while the plants were in the field. The present speculative indication is that the shorter photoperiods at the lower latitudes are chiefly responsible for the lengthened heads of this strain of cabbage in Texas, and that the deviation from exact proportions between photoperiods and head shape indices are due to the conditioning effects of the more variable environmental factors. Results of this nature emphasizes the need of adaptation

of new varieties during the course of their synthesis to localities for which they are intended, and perhaps, in many cases, of actually breeding and selecting varieties in the region where they are to be used.

Several selections of broccoli and of collards have been carried to the third generation with new individual selections being made in each generation. Broccoli is being selected for large, desirable heads on smaller plants. Several initial strains of collards are being selected for uniformly dark green and sessile leaved, low, compact, plants. Increased uniformity is apparent in several of these lines. A field test of the selected lines, against commercial ones, is planned for the fall and winter of 1940-41.

Attempts have been made to secure chromosome doubling in Copenhagen Market cabbage to secure increased cold hardiness. Colchicine concentrations of .2, .1, .05 and .025 per cents were about equally effective in inducing abnormality in the growing point, while .0125 per cent is much less effective. Two and three successive treatments at two-day intervals gave a larger per cent of abnormal stalk tips than did single treatments. Several of the resulting shoots have been found to have tetraploid ($2n=36$) roots, and appear to be tetraploid throughout.

W. S. Flory, J. F. Wood.

Factors Influencing the Quality and Yield of Onions

The use of fertilizer in the seed bed has materially increased the yield of U. S. No. 1 onions at the Winter Garden Station. Early Grano compares very favorably with Yellow Bermuda. Babosa, which is receiving some attention from commercial growers is evidently a strain of Early Grano. Results of fertilizer tests at outlying points in the Winter Garden agree with those secured at the substation that applications of potash are not usually profitable. Difficulty is being experienced in securing massed seed from inbred lines.

L. R. Hawthorn.

Pea Breeding

The following crosses were made during the past season: Rogers Ace x Thomas Laxton (60 seeds), Perfection x Thomas Laxton (75), Wisconsin Early Sweet x Thomas Laxton (75 seeds). Selections were made of Louisiana lines containing Creole genes. The following varieties are rated on a basis of stand: Perfection (best), Thomas Laxton, Rogers Climax, Wisconsin Early Sweet, Rogers Ace, and Early Gradus; and on a basis of weight of seed per plant: Perfection, Rogers Climax, Thomas Laxton, Rogers Ace, Wisconsin Early Sweet and Early Gradus. When the lateness of Perfection and Rogers Climax is considered their greater survival and production during the hot days of May seem notable. Selections through several generations are being grown in the greenhouse for seed increase.

There seems to be an effective natural selection under Texas conditions, on lines of peas developed elsewhere. Seed of Creole peas was grown

here first in 1938, and seed from the Texas grown plants lumped and saved. In 1939 some of the original seed and some of the Texas grown seed were planted side by side. Plants from the original seed yielded 6 grams of seed per plant, that from the Texas grown, first generation, seed yielded 8.38 grams per plant—an increase of over 25 per cent. This is as yet inconclusive, but will be tested on a larger scale to see if the survival of peas carrying genes for local adaptation actually does exert this effect on yield over a period of 1 or more generations.

The Thomas Laxton English pea was used to study methods of induction of chromosome doubling with a plant with a short seed to seed cycle. Plants 6 to 8 nodes high were treated with concentrations of .05, .025 and .0125 per cents colchicine for 1, 2, 4, 8, 14, 24 and 72 hours. Fewer seeds were secured from the stronger treatments but practically all were from affected areas. The most effective treatments appear to be .05 per cent for 1 hour and .0125 per cent for 8 hours. Five plants were used in each treatment. Fifty seeds were secured from the 105 treated plants, 22 of them occurring on shoots from markedly abnormal areas.

W. S. Flory.

Irish Potatoes

Variety Test: At the Lower Rio Grande Valley station yields of Katahdin, Chippewa and Warba were much better than that of Bliss Triumph, by as much as 3 times. Katahdin seems to be resistant to early blight, which is important in the area.

Cultural Experiments: Lack of the minor elements magnesium, manganese, iron and zinc does not seem to be a limiting factor in the Lower Rio Grande Valley. Other work is being done on the effect of commercial fertilizers and of irrigation.

W. H. Friend, J. F. Wood.

Sweet Potatoes

Adaptability and cultural experiments at the Sweet Potato Investigations Laboratory near Gilmer are discussed in full with the report of that laboratory. Cooperation with the Bureau of Plant Industry, U. S. Department of Agriculture, has been extended to include a part of the cultural work.

R. E. Wright.

Tomatoes

Adaptability and Breeding: At the Main Station a strain of Earliana showed evidence of resistance to Southern blight, caused by *Sclerotium rolfsii*. In soil well infested with this organism, plant survival was as follows: July 1, 94% and August 5, 64%. In contrast to this, survival for Bonny Best was 42 and 19% on these dates. Two selections of a cross involving Earliana had survival percentages of 70 and 43, and 64 and 49 respectively, while a third selection of this cross gave survival percentages about the same as for Bonny Best—43 and 20. Three other

unrelated crosses not involving Earliana gave similar results—52 and 22%, 39 and 19%, and 40 and 18%. Red Heart failed to live up to its name under our conditions and lacked quality. Wasatch Beauty was surprisingly early and well adapted to conditions at College Station. It seems to be a good home garden variety. The fruit is large and oblate. A number of the crosses show improvements in adaptability, combining a better quality fruit with earliness and high yield. One breeding selection produces fruit of excellent color at high temperatures.

At the Lower Valley station Break O'Day was crossed with J. T. D. as a possible means of securing hybrid vigor. Five additional crosses were made in connection with the breeding work. Rutgers, commonly grown in the Valley was late and puffed badly this season. Best producing varieties were Pritchard, Grothen's Globe, California Special Early, Valiant and Bonny Best. Most of the globe types, with the exception noted, were near the bottom of the list. Further selection of Summerset at the Winter Garden station is giving a somewhat larger and more uniform late fruit for production in Southwest Texas under irrigation. The selections differ widely in amount of seed production.

S. H. Yarnell, J. F. Wood, L. R. Hawthorn.

Cultural Treatments: A statistical analysis of the fertilizer results showed no significant difference between treatments at the Lower Rio Grande Valley station.

J. F. Wood.

Mineral Analysis of Turnip Greens

Seven Top turnips were grown under a number of fertilizer treatments at the Wichita Valley and Winter Garden substations and at the Main Station, and turned over, after harvest, to the Division of Rural Home Research for preparation for analysis by the Division of Chemistry.

B. S. Pickett, L. R. Hawthorn, S. H. Yarnell.

Effects from Treating Seeds with Chemicals in Dusts

Crucifer seed, one and three year old lots, and tomato seed, of the same ages, were dusted with Semesan, Auxan, alpha naphthalene acetic acid in charcoal, and Rootones No. 1, No. 5, No. 6 and No. 7. All of these except the Semesan were growth substance compounds in dust carriers. Also seed of cucumber, cantaloupe, English peas, Cow peas, *Habranthus robustus*, and Calendula were treated with the first 3 compounds. Data were taken on (1) time of germination, (2) percentage of germination, and—with English and Cow peas—on (3) type and extent of root development. Both cantaloupes and cucumbers gave significantly higher percentage of germination following Semesan treatment. Otherwise no significant differences in time or per cent of germination were observed from dust treated than from the untreated seeds in the check lots. Hormone treatment definitely increased the growth of lateral roots of English

peas. Following is the average total root growth in mm. in the 4 lots of English peas 12 days after planting and 5 to 7 days after emergence: Control 183.7, Semesan 115.6, Auxan 281.2, and Rootone 228.3. Laterals along the top 3 inches of the tap root were most affected; also there was some tendency for more than one "main" root to be formed following hormone treatment. While hormone treatment shortened the tap root of cow peas other effects were similar. It was observed that commercial Rootone (No. 1) stimulated root growth of crucifers more than did Auxan or Semesan.

W. S. Flory.

Ornamentals

Adaptability: Of the shrubs received at College Station within the last few years from the Office of Foreign Plant Introduction of the U. S. Department of Agriculture *Rhus vimilalis* has made the most vigorous growth. It has attractive evergreen foliage. The flower is inconspicuous, but very fragrant. Another introduction, *Melia* sp. (PI 105613, is a close relative of the Chinaberry, but grows much more rapidly. As might be expected the wood is brittle. Considerable native material has been added to the collection during the course of the year. This includes several species of Juniperus, Yucca and Acacia. The collection of amaryllidaceous plants has been increased by about 20 accessions, among them the newly described Cooperias, *C. Kansensis* Stevens, and *C. Smallii* Alexander.

Promising PI ornamentals received at Substation No. 3 in the Gulf Coast in recent years include *Quercus acutissima*, *Buddleia followiana*, *Cassia artemisioides*, *Melaleuca armillaris*, *Xylosoma senticosa* and *Eucalyptus microtheca*. Turn to reports of the substations for additional information in regard to these tests.

S. H. Yarnell, W. S. Flory, J. C. Ratsek and
substation superintendents.

Breeding: Number of pollinations, sets 15 weeks after pollination, and acorns gathered, respectively, from the 1939 oak crosses follow: (1) *Quercus virginiana* x *Q. lyrata*—226, 50, 27; (2) *Q. virginiana* x *Q. serrata*—227, 14, 1 (very small); and (3) *Q. virginiana* x *Q. Texana*—28, 0, 0. The second cross mentioned, live oak x Chinese oak, would seem to be a very desirable one to make if possible, and will be tried again. Several seedlings from each of the 1938 crosses of live x overcup, and live x post were set in the nursery. Four plants from each cross survived and are growing nicely.

Number of pollinations and seeds (usually 4 per berry) secured respectively from the 1939 holly crosses follow: *Ilex vomitoria* x *I. decidua*—60, 40; x *I. integra*—45, 72; *I. cornuta* x *I. vomitoria*—38, 12; x *I. integra*—55, 48; x *I. decidua*—27, 48; *Ilex opaca* x *I. vomitoria*—209, 264. *Ilex cornuta* branches bearing about 50 flowers were bagged, but not pollinated; 28 set at 8 weeks, and 2 mature berries with a total of 8

very wrinkled seeds resulted. Comparable experiments on *I. opaca* and *I. vomitoria*, each with many more than 50 flowers, gave no sets at all. This tends to confirm the impression previously gained that *I. cornuta* sets berries parthenocarpically. Four of the plants secured from the cross *Zephyranthes texana* x *Cooperia pedunculata* have flowered, and showed flowers, as well as foliage, typical of the mother species. Since these hybrids all have 24 somatic chromosomes like the mother, while the pollen species has 48, there seems little doubt that parthenocarp, reported to occur in *Z. texana* by Pace, has resulted here. A number of seeds and seedlings have resulted from the following 3 crosses: *Z. simpsonii* x *Z. treatiae*; *Z. atamosco* x *Z. treatiae*; and, *Z. simpsonii* x *C. pedunculata*. Whether these are true hybrids or parthenocarpic maternals must await further study for determination.

Chromosome number, and detailed morphology, have been determined for several species of *Cooperia*, and a preliminary report on the three species—*Traubii*, *pedunculata*, and *Drummondii* is in the press. *Cooperia Smallii* has since been observed to have 54 root tip chromosomes. Chromosome number and morphology on the native *Hymenocallis* sp. (probably *H. galvestoniensis*) is being worked out. The complement of 52 somatic chromosomes is remarkable in that it contains about 6 pairs with terminal constrictions. Counts on a number of species of *Habranthus* and *Zephyranthes* have been made. The bearing of cytological findings on the taxonomy of these groups is being especially considered.

W. S. Flory.

Budwood of 48 species of roses has been received at Substation No. 2 from the U. S. Department of Agriculture. Most of these are new to the collection or represent additional botanical varieties. Of the 1939 rose crosses, 268 combinations were attempted and 109 produced seed. *Rosa canina* produced seed with practically every pollen parent, as did *R. rubiginosa*. Nine pollinations of *R. setigera* x *Talisman* yielded nearly 800 seeds. Seeds of a good many of the 1938 crosses and a few of the 1937 crosses germinated during the past season.

Chromosome numbers have so far been determined at College Station on 51 F₁ hybrid rose plants from 21 of the different interspecific combinations secured in 1937. Plants from 13 of the crosses show expected chromosome numbers and behaviour. In the remaining 8 cases the following unusual conditions have resulted: (1) in a $4x \times 2x$ cross only $4x$ (instead of the expected $3x$) plants have so far been observed. (2) In a $5x \times 2x$ cross 5 hybrid plants are $5x$ as expected (pentaploid roses behaving irregularly at meiosis), but one $2x$ plant has occurred also. (3) From one cross, a $5x \times 2x$ one, where pentaploid hybrids are expected, the one plant examined has an additional chromosome, being presumably a hexasomic pentaploid. (4) In another, $4x \times 6x$, cross from which pentaploids are expected, the one plant examined is lacking a chromosome, being presumably a tetrasomic pentaploid. (5) From *lucida alba* (14) x *palustris*

(14 and 28 reported) one plant with 28 and another with 35 somatic chromosomes have resulted. (6) From Woodsii (14) x multiflora var. Welch (14?) two plants with 14, and the same number with 28 somatic chromosomes occurred. (7) From the cross gallica (28) x multiflora var. Welch (14?) one plant with 14, and two plants with 21 root tip chromosomes have occurred. (8) Blanda (14 or 28) x Woodsii (14) has yielded one 14 and one 21 chromosome plant. Explanations for most of these results, with the possible exception of the crosses involving the Welch strain of multiflora, seem apparent. Some root tips from certain hybrid plants have been found to contain more or less extensive polyploid areas.

Examination of 400 or more pollen grains from each of 53 of the rose forms used as parents in the 1939 species crosses shows that the per cent of apparently viable pollen varies, among the species, from 5.3 to 99.1. Thirty of these have more than 50% good pollen; eleven had less than 25% good pollen.

J. C. Ratsek, W. S. Flory, S. H. Yarnell.

Propagation: Further attempts to propagate the Ness Hybrid Oaks vegetatively have been made. A range of hormone treatments, including the "tooth-pick method," have been made with root cuttings. T-buds have been inserted in two-year-old seedlings of 8 different oak species or species hybrids. Following the tooth-pick treatments heavy calluses gave rooting promise. The buds, also, "stuck" and remained green for from 3 to 6 weeks. Final results, however, have continued to be negative. The problem will next be attacked by using cuttings from new, duplicated, hybrids; and by the making of (1) patch buds, and (2) bark grafts.

W. S. Flory.

Rose Investigations: A detailed account of the work on the effect of fertilizers and cultural methods, understocks, and storage on the condition of rose plants may be found with the report of Substation No. 2. A study of the effect of acidification of heavy soil has been made at Substation No. 6, Denton.

J. C. Ratsek.

Fruit Investigations Laboratory Montague, Texas

The Fruit Investigations Laboratory is located two and one-half miles southwest of Montague and nine miles northeast of Bowie, Montague County. Latitude is 33 degrees and 40 minutes north; longitude is 97 degrees and 45 minutes west; and elevation approximately 1166 feet above sea level. The total rainfall during 1939 was 24.52 inches.

The Laboratory farm consists of 56 acres of land. The soil types have been reported to consist of Windthorst and Stephenville fine sandy loam. Most of the land is typical of the fruit land in the northern portion of

the West Cross Timbers. Eleven acres are now planted in grapes. A portion of the land will be planted in tree fruits and berries in 1940.

The laboratory was established in January 1938 for the purpose of conducting investigations and research in problems of grape production, and to find ways of processing Texas grapes to find a ready market. Additional work was added to the laboratory in the fall of 1939 to conduct studies with tree fruits and berries. No grapes have been produced on the Station vineyard as the oldest vines have not reached bearing age. The grape vines have made excellent growth, which indicates very satisfactory natural conditions for grape production.

Grape Variety Adaptability: The Carman grape is recognized as the leading commercial variety in North Texas. This variety is highly resistant to insects and diseases, and seems to be better adapted to the soil and climatic conditions than other varieties being grown. Two hundred and nine varieties have been planted in the Station vineyard largely of the American with a few European varieties. The planting consists of five plants of each variety for comparison with the Carman. Thirty-seven varieties produced more vine growth than the Carman as measured by the length of canes. The variety planting will be increased in 1940 to include eighty-seven additional varieties, species and hybrids grown from cuttings in 1939.

Grape Fertilizer Test: Eight applications of commercial fertilizers and one of barnyard manure were applied. The vines that received applications of fertilizers and manure produced more growth than the unfertilized vines. There was no apparent difference in the amount of growth with vines that received complete fertilizer, nitrogen, or nitrogen and phosphorus. With varying amounts of 6-12-6, the vines which received 300 lbs. produced more growth than those that received 600 and 900 lbs.

Grape Pruning and Training: Three systems of pruning and training are being studied; namely, single-trunk four-cane Kniffin, Munson, and the modified renewal. The commercial vineyards are trained to both the Kniffin and modified renewal systems; the latter is probably used more extensively. Vines produced about the same amount of growth the first year trained to the modified renewal and Kniffin systems. The vines trained to the Munson system produced the least amount of growth. The trunks of the vines trained to the modified renewal system made slightly more growth in diameter.

Grape Terrace Plantings: There was a decided increase in the amount of vine growth of vines above, on top, and below the terrace over those between the terraces. Vines on top of the terrace made the greatest amount of growth, followed by those above the terrace, and those below the terrace.

Grape Elevation and Soil Type Plantings: Grape plantings were made in 1938 on top of the hill, side of the hill, lowland, and in different soil

types on side of hill to study the vine growth, yield and quality of fruit. The planting on side of hill in deep fine sandy loam soil exceeded other plantings in diameter of trunk and length of canes. Other plantings ranked in vine growth as follows: side of hill, deep blow sand; top of hill; lowland; and side of hill, average soil. The last is typical of the grape and fruit planting of this area. The planting in the deep sandy loam soil made more than twice as much of cane growth as the planting in average soil on the side of hill. The depth of soil apparently has much influence on the amount of vine growth.

Grape Spacing Test: At the end of the second year in the vineyard, vines produced practically the same amount of growth spaced 8 x 12 ft., 10 x 12 ft., and 12 x 12 ft.

Grape Insects and Diseases: The grape leafhoppers were very numerous in local vineyards during the 1939 season. Amount of black rot infestation was especially light. No leafhoppers attacked the laboratory vineyard, and only slight infestation of black rot. A program of five spraying and dusting schedules has been outlined to combat insects and diseases, but no applications were made during the past season.

Grape Cover Crop Test: This test consisted of plantings of a mixture of oats, wheat, and barley; Austrian winter peas; and hairy vetch. None of the crops produced a cover. Perhaps the failure was due to late seeding and severe damage from rabbits.

Grape Rootstock: Nursery tests with bench grafts were begun in 1939. La Pryor used as a graft stock in combination with Carman, Delaware, and Virginia gave the highest percentage (32.92) of graft unions. Other stocks tried with the same varieties include a local species (21.66), Champanel (21.66), and Dog Ridge (15.83). The scions varied in percent union with the different stocks. Carman and Virginia united best with La Pryor; Delaware united best with the native species. Grafts placed in a heeling pit before planting gave a higher percent of unions than those planted direct to the nursery row. The test of treatments indicated that neither Hormodin "A" in 20 B.T.I. units nor Auxilin in .004 percent concentration give root stimulation of grafts. Grafts with the top of scions coated with paraffin gave the highest percent of unions.

Grape Propagation: Cuttings of Carman, Delaware and Virginia planted direct in the nursery gave a higher percentage of rooted plants than cuttings placed in a heeling pit before plantings. As compared with Dog Ridge, Champanel and La Pryor, ten hybrids and one species produced a higher percentage of rooting from cuttings. Four of these hybrids rooted 100%. Hormodin "A" in 20 and 40 B.T.I. units increased the percentage of rooting from about 58 to 76 per cent when the cuttings were placed direct in the field, but not when first callused. When the cut is made just above the top node and at the middle of the internode at the bottom the highest percentage (90) of rooted cuttings resulted; followed by those cut just above the top and just below the bottom node,

and those using basal end of canes and cut just above top node (both 67.5); both ends chopped off with hatchet above and below nodes (62.5); cut top at middle of internode and bottom just below node (60); one-fourth of internode left at top and bottom (50); and, cuttings with both ends cut at middle of internode (10).

Grape Products Test: Grapes were secured from local growers during the past season. Juice was extracted and bottled from the varieties Niagara, California, America, Beacon, Mustang, Wapanuka, Delaware, Concord, Carman, Black Spanish, Catawba, Virginia, Caco, Wine King, Fern Munson, Herbemont, and *Vitis cordifolia*, and shipped to Substation No. 3 for blending studies. In general the total solids of the grape juice were lower in 1939 than in 1938. The lower proportion of total solids with some of the grape varieties may be attributed to one or several factors; namely, treatment of the land (lack of terracing and proper cultivation to conserve the moisture), insect and disease damage, immature fruit, or unpruned vines. The difference in total solids of Carman grapes from terraced and untterraced vineyards indicates that grapes from terraced vineyards produce a higher per cent of total solids. Grapes harvested from a terraced vineyard six days before grapes from an untterraced vineyard gave 23.88 per cent total solids, whereas, the grapes from the latter gave 18.96 per cent total solids. When grapes were left on the vines as long as possible in both the terraced and untterraced vineyards, the grapes from the terraced vineyard produced 10.34 per cent more total solids than the grapes from an untterraced vineyard. The grapes shriveled and ripened immaturity in the untterraced vineyard, which made it necessary to harvest, due to the berries shattering, seven days sooner than grapes from the terraced vineyard. Carman vines grown on terraced land produced more compact clusters, larger berries, and the fruit was fully developed when ripe. These differences in the quality of fruit were probably due to some extent to the fact that the vines were young in the terraced vineyard. They also had less infestation of leafhoppers than the mature vines in the untterraced vineyard.

Brix tests with the Carman variety through the ripening season indicate that the growers harvest their grapes before the sugar content has fully developed, and perhaps from two to three weeks too soon to be of best quality for the fresh fruit market and also for the manufacture of grape juice. It is the practice of many growers to begin harvesting as soon as the grapes have developed the natural ripe color. A few of the grape varieties as the Delaware and Catawba are edible at this stage, but most of the varieties require several days to ripen fully after they turn in color. The Brix increased with the Carman variety from 11.2 on July 22 which was about one week after the growers began harvesting, to 18.96 on August 10, the end of the harvesting season.

U. A. Randolph, H. M. Reed.

Ornamentals

Trees and Shrubs: The planting of trees and shrubs on the Station grounds include only species native to Texas. Twenty-five species were planted in 1939. Most of these plants are showing promise as ornamentals. The *Salvia regia* attracted much attention because of its production of an abundance of light red flowers in the late summer and fall. It made excellent growth with and without irrigation.

U. A. Randolph.

Sweet Potato Investigations Laboratory Gilmer, Texas

The Sweet Potato Investigations Laboratory is located in Upshur County, two miles south of Gilmer, on highway U. S. 271. The farm consists of 80 acres, with 35 acres in cultivation. Ten acres were devoted to experimental plats during 1939.

Two years' work has been completed at the Laboratory, the main object of which was to secure information that growers can use to raise their average production of 75 bushels per acre to a profitable level. The need of a uniform strain of Porto Rico, the principal commercial variety, is in evidence, and some progress has been made on this project.

Fertilizer Test: Response to fertilizer was not as great this season as was noted on the same plats during 1938. The unfertilized check plat produced a total yield of 75 bushels, as compared with 130 bushels per acre when fertilized with 600 pounds of 4-12-4. In the rate of application test, yields increased as the fertilizer was increased to 600 pounds per acre. As previously reported, a deficiency of either of the essential elements (nitrogen, phosphorus, and potash) considerably reduced vine growth and yields. Increasing amounts of each of the essential elements was characterized by fairly consistent increases in yield of sweet potatoes.

Time and Method of Application of Fertilizer: The object of this test is to determine whether all the fertilizer for sweet potatoes should be applied before or after setting the plants, or whether a combination of these methods would be most profitable. Response to fertilizer this season was not great enough to draw conclusions, and will be repeated.

Dates of Planting and Differential Spacings: Plantings were made on April 18, May 22, and June 10, using the following spacings in three and one-half foot rows: 9, 12, 15, 18, and 24 inches. The average total yield from each date of planting was as follows: April 18, 260 bu.; May 22, 94 bu.; June 10, 72 bu. Due to the fact that sweet potatoes did not produce slips in open beds until around May 20, plantings for the area as a whole were late. Differences in yield due to various spacings were comparatively small, the 15 and 18 inch spacings being the most economical.

Height of Beds: Four-row plats fertilized at the rate of 600 pounds of 4-12-4 per acre, were made up into beds as follows: level, 3 inches,

6 inches, 9 inches and 12 inches high. Although the yield of sweet potatoes was low on all of these plats, the 6 inch beds produced significantly the highest yield as well as the highest percentage of U. S. No. 1 sweet potatoes.

Dates of Harvesting: Plants were set in the field on April 28, and plats were harvested after 126, 141, 155, 172, and 200 days. Although the date of harvesting had little effect on yields this season, samples from each lot were stored for information on keeping quality and slip production.

Size of Seed: Porto Rican seed of the following sizes were bedded for this test: jumbo, U. S. No. 1, U. S. No. 2, turnip shape, and strings (less than $1\frac{3}{4}$ inches in diameter). Due to unfavorable weather conditions the yield on these plats were so low that differences were not significant. New seed will be obtained and the test continued.

Cover Crop Test: Due to increasing interest in cover crops in the sweet potato producing counties, oats, vetch, and bare check plats were followed by sweet potatoes, with and without the use of commercial fertilizer. Oats produced 2.41 tons and vetch 6.15 tons of green matter per acre by April 24. As the season was abnormally dry, the cover crops did not decompose thoroughly, and showed no increase in yield of the following crop of sweet potatoes.

Comparison of Rooted and Cut Slips: Fourteen bushels of Porto Rico sweet potatoes were bedded, the slips being pulled from half and cut above ground from the other half. Plant production was slightly higher when cut from the bed, as new plants originated at buds on the stems instead of the buds on the mother potato. When planted in replicated plats on May 17, the rooted slips produced 90 bushels and the cut slips, or vines, produced 125 bushels per acre.

Variety Adaptability Studies: Ninety lots of sweet potatoes, including selections, mutations, seedlings, and named varieties were tested in replicated plats this season. In spite of generally low yields, 10 of these lots produced over 200 bushels per acre. Yields in this test ranged from a high of 281 bushels for U. S. D. A. seedling 029881, down to several complete failures. This test is being run in cooperation with the United States Department of Agriculture. Small lots of 87 new seedlings were received from the U. S. D. A. this season.

R. E. Wright.

RANGE ANIMAL HUSBANDRY

Disease Resistance in Animals

(In cooperation with Division of Veterinary Science)

Observations have been continued on the preliminary selections made last year of sheep for resistance to the stomach worm, *Haemonchus con-*

tortus. Of the twelve aged sheep reported in the selected group last year, nine ewes are living and in good health. These have been maintained continuously under conditions of intensive natural exposure, without medicinal treatment. Of this group, the two Romney ewes have now been maintained under these conditions, without treatment for over two years, and the Rambouillets for more than one year. Three of the ewes temporarily showed slight symptoms as indicated by their lowest hematocrit readings (volume of red blood cells). Three additional yearling ewes were added and have not been treated for nearly a year. Selected rams were not yet available when the ewes were bred last year, so the lambs from these ewes represent only partial selections. The ten lambs from these ewes have never received treatment for stomach worms and have been continuously exposed to intense natural infestation. Four died from *haemonchus* parasitism, and two others showed definite marked symptoms. The other four showed symptoms so slight that they could only be detected by hematocrit readings. Two of these are rams, one of which is already in breeding service to the selected group of ewes. Of six unselected Rambouillet grade lambs which have not received treatment, two showed marked symptoms of parasitism, while four showed only slight symptoms. Two lambs from Rambouillet mothers and sired by a Mouflon (*Ovis musimon*) ram were also included in these tests. One of these lambs showed very severe symptoms, including swelling under the jaw, but has not died. The other one has never shown any symptoms of parasitism.

Regular egg counts from the feces and red cell volume as indicated by hematocrit readings have been made. A simple system of recording the intensity of color in the conjunctiva (lining of the eye-lid) has also been found to be highly correlated with the hematocrit readings. All the exposed animals had eggs of the parasite in the feces in greater or lesser quantities. It seems that the appearance of the conjunctiva and the hematocrit readings are better indicators of the resistance of the animal, than is the egg count. Work is being continued with pure cultures of *Haemonchus contortus* using baby lambs in an attempt to perfect a technique for testing the resistance of the animals in a shorter period of time than is now possible.

Further selections in mice for resistance to *Nippostrongylus muris* and to the toxin of loin disease have been continued, but no new findings are ready for report.

B. L. Warwick, H. Schmidt, R. D. Turk, R. O. Berry.

Cytological Studies in Sheep and Goats

Observations on testicular material from young and adult Rambouillet sheep have shown that the material best suited for chromosome studies may be obtained from the young animal just as it is coming into sexual maturity. Cell division in the tubules of the testes apparently reaches the

peak of its activity at this period. The time of this abundant mitotic activity is correlated with the size of the testes and the size and firmness of the epididymis. It is also indicated by the occurrence of the first sperm (relatively few in number) in the epididymis.

By using a modification of the aceto-carmin technique, this method has been adapted for use in the study of testicular tissue in mammals. The method is a marked improvement over those previously used in both the saving of time and in the accuracy of observations. It permits a more detailed morphological study of spermatogonial chromosomes because cells are studied which have not been subjected to shrinking by dehydration and embedding in the preparation for sectioning. However, the sectioned material as well as whole mounts of the amnion has a place in this study and is being used to supplement the aceto-carmin method.

Favorable testicular material has been obtained for a critical study of chromosome morphology and number in the domestic goat, the domestic sheep and the hybrid between the Rambouillet x Mouflon. Preliminary studies on the chromosomes from the testes of the Rambouillet sheep have thus far revealed a condition very similar to the observations in the somatic cells of the amnion. The six largest chromosomes are V-shaped. This point has been carefully considered since other workers on testicular material have interpreted their findings otherwise.

R. O. Berry and B. L. Warwick.

Inheritance of Polled Character in Fine-Wool Sheep

Nine more Rambouillet rams raised in the station flock from polled breeding have been tested for homozygosity. Four of these were found to be homozygous or pure-breeding for the polled or hornlessness pair of genes. However, three of the homozygous rams also sired cryptorchid or "ridgling" sons, and one of them carried the gene for one of the recessive blacks. One of the rams is being tested further for the cryptorchid gene, which we had previously found to be segregating in our stock as a recessive. He is also being tested further for recessive black. This ram is the first Rambouillet ram with definite scurs that we have found by test to be homozygous for the principal dominant pair of genes for polled, or hornlessness. Scurs in the males of polled strains are evidently due to additional genes, which are probably recessive. However, this is not certain, as the expression of this character is repressed in females which are either homozygous or heterozygous for the principal pair of genes for polled. Additional information on this point was gained from the observations on a small group of F_1 Rambouillet (horned stock ewes) x Romney. The Romney is an old established hornless breed. Every F_1 ram that was raised to one year of age had very definite scurs. This is in contrast to breeding within the pure-bred Rambouillets where part of the F_1 and other heterozygous polled rams were entirely free from scurs.

The study of polled and horned inheritance with Merinos, which was started last year, in cooperation with the Animal Husbandry Department, School of Agriculture, has been continued. The second polled ram used in the Merino flock was also tested by breeding to known mothers of cryptorchid or "ridgling" rams from our grade polled Rambouillet stock. One of the lambs is a "ridgling." This ram was also bred to black tester ewes and all eleven lambs produced were white. However, we have evidence, as noted last year, indicating that there are probably two different pairs of recessive genes in the range fine-wool flocks, either of which may produce black. With only part of the black tester ewes, is it definitely known as to which of these genes are present.

Further tests to separate out non-carriers in both Rambouillets and Merinos are in progress, with the expectation that "ridgling"-free and recessive black-free strains of both polled Rambouillets and polled Merinos will result.

B. L. Warwick, J. M. Jones, W. H. Dameron,
P. B. Dunkle, and A. K. Mackey.

Inheritance of the Ridgling Characteristic in Goats

The most rigid selection against the cryptorchid or "ridgling" defect which has been made during the 23 years that the Ranch Station stud flock has been in existence, was put into effect in 1936-39. This consisted of both the elimination of all mothers of "ridglings" and the elimination of all known "carrier" males except one, and he is eliminated as the sire of future kid crops. No "ridgling" has ever been used as a sire in this stud flock. The average occurrence of "ridgling" kids during the 23 years was 6.1 per cent of the males born, varying by years from 0 to 14.3 per cent. Since the more rigid selection has been in effect, the incidence has dropped from 12.5 per cent in 1936 to 0 in 1939. The only other years in which there were no "ridgling" kids were in 1917 while the flock was yet very small and only five male kids were born, and in 1925 which followed some culling of dams on this basis.

Further testing of bucks from the Ranch Station has been made at the F. and B. Station by breeding them to "ridgling"-bred females and known mothers of "ridglings," but none are yet known with certainty to be free from the recessive genes of both pairs which are concerned with this defect.

B. L. Warwick, W. H. Dameron, J. M. Jones.

Inheritance of Type in Angora Goats

Additional data have been secured on the classification of mohair locks. This classification is being compared with standard commercial grades. No new findings are ready for report.

J. M. Jones, B. L. Warwick, S. P. Davis, W. H. Dameron.

A Study of the Inheritance of Skin Folds on Rambouillet Sheep

(In cooperation with U. S. Dept. of Agriculture)

Additional study of the Corriedale (free from skin-folds) x Rambouillet (C and B types) has been made. Besides the F_1 in which the skin folds values were low, a small group of F_2 animals have been studied in detail. Compared with the sires as 100, they range from less than 1 to 81 in values. There is a suggestion of definite segregation, but the small number of 23 individuals is too meager for definite conclusions. Study is being continued of the segregation in matings of pure-bred Rambouillets but no new findings are ready for report.

J. M. Jones, B. L. Warwick, W. H. Dameron,
S. P. Davis, H. C. McPhee, D. A. Spencer.

Relation of Age of Animal to Fineness of Wool and Mohair

The relation of age of animal to fineness of wool is significant, but the differences of fineness with age are not nearly so great as those found with mohair. These differences are not great enough to be of commercial importance but are important from the standpoint of stud breeding. Besides age, the sex, type, and fertility of the animal, and the season all are definitely related to fineness of wool. Thirteen years data on the wool are now in manuscript form for a bulletin.

J. M. Jones, B. L. Warwick, S. P. Davis, W. H. Dameron.

The Inheritance of Fiber Characteristics in Rambouillet and Romney Sheep and Their Crosses

This project has for its primary purpose the study of the inheritance of staple length together with the transference of some additional staple length to the Rambouillet breed from the Romney. The Rambouillet ewes have now been bred to F_1 rams and the F_1 ewes to a Rambouillet ram. The first $\frac{3}{4}$ Rambouillet x $\frac{1}{4}$ Romney lamb has just been born. The F_1 sires used have about 10.0 cm. growth of staple in a year (which is nearly four inches), and selections will be made in the next generation with special emphasis on staple length.

B. L. Warwick, S. P. Davis.

Sheep Breeding for Blackland Area

The Blackland area is potentially a winter fat-lamb producing area. One of the reasons this type of production has not yet become of major importance is the lack of an entirely suitable breed or strain of sheep for the purpose. In order to be entirely suitable, they should, (1) have the early summer breeding habits so that the lambs may be born in the fall or early winter, (2) have extra good milking ability, (3) have good mutton conformation, (4) have ability to stand the summer heat, (5) be free from skin folds, (6) be hornless in both sexes, and (7) have short wide spreading hoofs so that mud will not affect them seriously. In

order to produce such a breed, initial crosses are being made of high grade Rambouillet ewes with both Romney and Dorset rams at Substation 5. About 25 per cent of the Rambouillet ewes are polled (i. e., not only lack horns, but also have the depressions typical of polled breeds). These and the F_1 Rambouillet x Romney ewes are being bred to Dorset rams. It is the expectation to back-cross with rigid selection until the sheep are $\frac{7}{8}$ Dorset breeding, when the animals will be bred *inter se* and further selections and breeding tests will be employed.

C. H. McDowell, B. L. Warwick.

Transference of the Genes for Fineness of Fiber from Non-Angora to Angora Goats

(Cooperative with Department of Animal Husbandry, A. & M. College)

For a number of years the Experiment Station has kept from 25 to 50 cross-bred and non-Angora goats for use in genetic studies. Most of these animals have very fine fibers mixed with the large amount of coarse hair or kemp. One of these, which is the F_1 from a common white milk goat x Angora male, is now eight years old. The small amount of true mohair present is fine enough to be classed as either first kid or super-kid, if it were not for the large amount of kemp or hair mixed with it. A yearling male sired by an Angora buck and out of this doe had the finest mohair of the group of males of the same age. He has been bred to about 70 pure-bred Angora does. The objective is to carry enough of the genes for adult fineness of fiber over from the non-Angora to the $\frac{7}{8}$ or 15/16 Angora, so that we may have a sound basis for selection.

B. L. Warwick, S. P. Davis, A. K. Mackey.

Interspecific and Intergeneric Hybridization with Sheep and Goats

Additional matings of male Mouflon (*Ovis musimon*) x Rambouillet females were made and 5 more young were produced. The Mouflon, in common with all wild species of true sheep, have short tails. X-ray examination revealed eleven coccygeal vertebrae each, in our pair. Our Rambouillets vary from about 18 to 21 or more. The number of vertebrae in seven F_1 individuals have been checked, five individuals having 15 each, one has 14, while one still-born had only 12. The external appearance of the F_1 is also intermediate. The F_1 males raised last year have been back-crossed to Rambouillets and six lambs have been born. One of these closely resembles the F_1 lambs, while the others look more like the Rambouillets. The tails of these $\frac{3}{4}$ Rambouillets and $\frac{1}{4}$ Mouflon vary from about the length of those of the F_1 to that of the Rambouillet.

Seven female Angora goats have been bred to one of the F_1 Rambouillet x Mouflon rams. One aborted while of the others, one was re-bred late in the season to a goat. The other five apparently became pregnant, but pregnancy period has not yet been completed. One F_1 Rambouillet x Mouflon ewe was bred to a male goat, but was re-bred to a sheep 51 days later.

The coat of the Mouflon is predominantly hair, with an under-coat of true wool which is very fine, comparable in this respect to the wool of Rambouillets and Merinos. The F_1 has a birth coat quite comparable to that of the Mouflon parent, but sheds a large portion of the hair during the first few months after birth. The fleece grown from six to twelve months of age is predominantly fine wool, but still has too much hair (which would commonly be considered kemp) to be valuable commercially. The birth coats of four of the $\frac{3}{4}$ Rambouillet x $\frac{1}{4}$ Mouflon are indistinguishable from that of the pure Rambouillet, while the others are similar to that of F_1 .

B. L. Warwick, R. O. Berry, S. P. Davis.

Vitamin A Requirements for Beef Cattle and Sheep

(In cooperation with Substation No. 7, Spur, Divisions of Chemistry and Veterinary Science, and Bureau of Animal Industry, U. S. D. A.)

In this experiment, conducted at the Spur Station, which comprised the fifth in the series, 50 head of 464-pound Hereford steer calves were depleted by feeding a vitamin A deficient ration composed of 3 per cent tankage (60 per cent protein), 10 per cent cottonseed meal and 87 per cent cottonseed hulls plus .10 pound of limestone flour per head daily. They were fed as a group until depletion (indicated by night blindness), when each animal was placed in an individual pen and fed dehydrated alfalfa leaf meal to supply 800 micrograms of carotene per hundred pounds of body weight daily until 45 were depleted. At that time the remaining 5 were placed in their individual pens and all were started on a fattening ration composed of 3 per cent tankage, 15 per cent cottonseed meal, 30 per cent ground threshed sorghum grain, and 52 per cent cottonseed hulls plus .10 pound of limestone flour per head daily. The five undepleted steers and the five lowest gaining steers of the 50 head were not used in the main grouping but were used as extras, 2 on each level, so that 5 test groups of 8 steers each were used. The 9 depleted individuals in each group were fed dehydrated alfalfa leaf meal to supply 800, 1,000, 1,250, 1,500 and 2,500 micrograms of carotene per hundred pounds body weight daily beginning at the same time as the fattening ration, but the undepleted animal in each group did not receive alfalfa until he became depleted. The fattening period was 140 days in length and the grain in the ration contained enough carotene to add about 50 micrograms per hundred pounds body weight to that supplied in alfalfa. The average carotene levels fed in alfalfa and grain were 836, 1,034, 1,286, 1,508, and 2,485 micrograms daily per hundred pounds body weight for the 140-day period.

The mean gains per head for the 5 carotene levels were 202.6, 240.5, 248.25, 253.25, and 250.12 pounds respectively. Statistical analysis of the data revealed no significant difference among the gains except between groups 1 and 3, 1 and 4, and 1 and 5, since a mean difference of 44 pounds was required to be significant.

With the exception of 2 steers, all of the animals on the 4 lower levels were completely night blind at the close of the test. Three steers on the low level became completely day blind. The general tendency in night vision of the animals on the high level was toward greater impairment as time went on, but only 2 of the 9 individuals were completely night blind at the end. Only one, however, was normal in night vision.

Convulsions were noted in all of the 3 lower levels. In Group 1, 6 individuals were observed in convulsions a total of 22 times of which 11 were for one steer. Five animals in Group 2 were noted in convulsions one time each.

Generally speaking, the animals on the 800 microgram level were much more sluggish than those fed the higher levels and were considerably harder to keep on feed. Their feed consumption was also somewhat less than that of the other groups. Swelling of the hocks was noted in all groups but was not so prevalent in Group 5 as in the others.

J. H. Jones, R. E. Dickson, J. M. Jones, J. K. Riggs.

Cottonseed Meal in Rations of Ground Milo Heads and Silage for Fattening Steers

(Substation No. 7, Spur, Texas.)

With a supply of low priced milo heads and silage in the fall of 1938, and with cottonseed meal relatively high in price, questions re-occurred in regard to the amounts of cottonseed meal which should be fed for fattening livestock.

Three lots of 800-pound steers were fed none, 2.5 and 5.0 pounds of cottonseed meal per head in addition to a full feed of ground milo heads and sumac silage. In this feeding trial the mid-amount of cottonseed meal (2.5 pounds) was the most practicable amount to feed, for it produced a very satisfactory gain at low cost and the steers attained high finish in 144 days. The cattle fed no cottonseed meal made satisfactory gain at low cost but lacked somewhat in finish and were rough in coat. The larger amount of cottonseed meal (5 pounds) produced only slightly greater gains than 2.5 pounds and at greater cost.

J. H. Jones, R. E. Dickson, J. K. Riggs.

Limited and Deferred Feeding of Grain with Rations of Cottonseed Meal and Silage

(Substation No. 7, Spur, Texas.)

Previous work has shown that yearling steers can be well fattened in about 200 days on rations of silage and 5 to 6 pounds of cottonseed meal without the use of grain. This method of feeding affords a means of disposing of large amounts of silage and has definite possibilities for profit when grains are scarce and high in price and silage is abundant and cheap. It has the disadvantage of producing only moderate gains, because

it is impossible for cattle to consume sufficient silage to secure the nutrients required for making high gains. In West Texas this method of feeding forms a basis from which to work in lean years when little grain is available, and in years when only limited amounts of grain are produced the question arises as to the best method of utilizing it.

Three lots of 700-pound steers were fed the following rations for a period of 200 days:

Lot 1, sumac silage, ad libitum and 5.27 pounds cottonseed meal.

Lot 2, sumac silage, ad libitum and 5.25 pounds cottonseed meal, 7.5 pounds ground milo heads fed during the last half of the feeding period.

Lot 3, sumac silage, ad libitum, 5.25 pounds cottonseed meal, 3.83 pounds ground milo heads fed during the entire feeding period.

The object of the experiment was to determine the value of adding a limited amount of ground milo heads to a ration of sumac silage and cottonseed meal when the milo was fed (a) during the entire feeding period, and (b) only during the last half of the feeding period.

The addition of 3.83 pounds of ground milo heads daily to the ration of silage and cottonseed meal increased the amount of finish but did not increase the gain. The addition of 7.5 pounds of ground milo heads during the last half of the feeding period gave slightly greater gain and finish than cottonseed meal and silage alone, and slightly greater gain but less finish than 3.83 pounds of ground milo heads during the entire feeding period.

J. H. Jones, R. E. Dickson, J. K. Riggs.

Feeding Problems Affecting Beef Production

(In cooperation with Big Spring Field Station, Bureau of Animal Industry, U. S. D. A.)

In this 196-day fattening trial with 528-pound Hereford steer calves to determine the efficiency of grain utilization when ground threshed milo was (1) full fed, and (2) 80 per cent full fed, the results were no doubt complicated by the occurrence of bloat and urinary calculi, for six of the Lot 1 steers and eight of the Lot 2 steers were affected by either or both of these conditions in the course of the feeding period. The occurrence of the urethral condition in two consecutive tests with similar rations fed to two different herds of steers indicates a faulty feed combination. Stoppage of the urethral tract, only among the steers kept in close confinement, indicates that this condition is aggravated by lack of exercise.

Between the two lots of steers fed individually, those receiving limited grain were more efficient in the utilization of grain than the ones which were full fed. The higher gain and finish for limited grain feeding was contrary to previous findings. Between the two lots of steers fed in groups,

the full fed lot made greater gain, higher finish, sold at a higher price, returned a larger profit and on such bases were more efficient in the utilization of grain although requiring more grain to produce a cwt. of gain.

The group-fed steers maintained better appetites with less variation in amounts of feed consumed than those individually fed. Despite a 28-day preliminary feeding period in addition to the test period of 196 days, none of the lots except the one full fed as a group became highly finished.

J. M. Jones, F. E. Keating, W. H. Black,
Paul E. Howe, J. H. Jones.

Fattening Steers in the Madera Valley

(Substation No. 9, Balmorhea, Texas.)

Three of six lots of ten 707-pound feeder steers were fed ground hegari fodder and three were fed hegari silage. In respective order, the three lots in each group received 0, 2, and 4 pounds of ground alfalfa hay. The hegari silage and hegari fodder were harvested from the same crop. All lots received the same supplements of cottonseed meal and ground milo grain, the grain not being fed for the first 112 days of the 195-day feeding period. The lots receiving the ground hegari fodder were self-fed; those receiving silage were hand-fed twice daily.

During the first 112 days the lots fed hegari fodder made an average daily gain of 2.57 pounds; those receiving silage 2.13 pounds; but during the last 83 days the daily gain was higher for the silage steers, 2.38 pounds as compared to 1.81 pounds. Average gains for the entire period were much the same for all lots but the fodder-fed lots made higher dressed yield and returned slightly firmer carcasses. It is possible that the greater gains secured during the first 112 days with hegari fodder was caused by a more complete utilization of grain in the fodder than in the silage. Later, with grain added as a supplement, this difference became less important and the silage fed steers made greater gain.

The lot fed hegari fodder without alfalfa made slightly greater gain than any other lot; however, this was not consistent with previous trials which indicated that small amounts of alfalfa increase the gain even though the rations already contain adequate amounts of protein. A greater gain for the silage lots which received alfalfa indicated that a small amount of dry roughage should be fed along with silage.

At the prices charged, \$3.50 per ton for silage and \$8.00 for fodder, and with the steers eating approximately 2.27 pounds of silage to 1 pound of fodder, there was little difference in financial return.

J. H. Jones, J. J. Bayles, J. M. Jones.

Dried Citrus Peel and Pulp in Cattle Fattening Rations

(Substation No. 1, Beeville, Texas.)

In a 168-day (second test) feeding period, it was indicated that from 25 to 60 per cent of ground ear corn may be safely replaced by dried citrus peel and pulp in rations for fattening weaned steer calves. Furthermore, the above indicated percentages of citrus feed in the rations proved to be fairly palatable when care was taken to make gradual increases in the amounts fed.

Gains based on both feedlot and market weights favored the check lot fed corn only with cottonseed meal and silage and with similar prices charged for both ground ear corn and citrus feed, financial return favored the lot fed corn. Carcass weights, carcass grades and dressing percentage favored the lot in which 25 per cent of the corn was replaced with citrus feed. Less favorable results were shown by the lot receiving the larger amount of citrus feed. Considering all factors involved, the test indicated that the replacement of 25 per cent of the ground ear corn with dried citrus peel and pulp increased the efficiency of the fattening ration while 60 per cent resulted in a decrease in efficiency.

J. M. Jones, R. A. Hall, Edward M. Neal, J. H. Jones.

The Winter Feeding of Steer Calves

(Substation No. 1, Beeville, Texas.)

It was indicated that green oat grazing had higher value than sorgo silage in a winter feeding test with two lots of 20 steer calves each. In a 42-day period, Lot 2, receiving green oat grazing with access to chopped hegari bundles, made 30 pounds less gain per head than Lot 1, full fed in dry lot with sorgo silage and with supplements of 2 pounds of cottonseed meal and 2 pounds of ground ear corn per head daily. In the succeeding 56-day period, Lot 2 made 67 pounds greater gain than Lot 1 when fed the same supplements of cottonseed meal and ground ear corn in addition to the oat grazing. Also, in the following 26-day period on green sudan grazing with an equal number of steers in each lot receiving the same treatment in regard to supplementary feeds of cottonseed cake and ground ear corn, Lot 2 steers made 22 pounds more gain per head.

J. H. Jones, R. A. Hall, Edward M. Neal, J. M. Jones.

Beef Cattle Feeding Investigations Relating to Mineral Deficiency Studies in Range Beef-Cattle Production

(In cooperation with Divisions of Chemistry and Veterinary Science, and Bureau of Animal Industry, U. S. D. A.)

The mineral feeding experiment with range cattle begun in Brooks County, January 1938, in cooperation with the Bureau of Animal Industry, U. S. Department of Agriculture, and the King Ranch, was continued in 1939. The four groups of cows were handled as follows: Group 1, no

supplement; Group 2, raw feeding bone meal to give—dry cows, 6.5 gms. phosphorus and 13 gms. calcium, wet cows, 14.3 gms. phosphorus and 28.5 gms. calcium; Group 3, disodium phosphate to give—dry cows, 6.5 gms. phosphorus, wet cows, 14.3 gms. phosphorus; Group 4, raw feeding bone meal to give all cows 6.5 gms. phosphorus and 13 gms. calcium, also 160 mgms. iron, 100 mgms. manganese, 15 mgms. each of copper, cobalt, boron and zinc. The amounts of the supplements fed in Groups 2 and 3 were increased for each cow as she calved. Average weight gains or losses of the cows for the period from December 29, 1938 to December 28, 1939 were: Group 1, —38.5 pounds; Group 2, 7.7 pounds; Group 3, —24.1 pounds; Group 4, —12.6 pounds. Group 1 produced a 76 per cent calf crop as against 92 per cent in Group 2, and 88 per cent in Groups 3 and 4. The number of pounds of calf produced per cow for each group are as follows: Group 1, 311.6 pounds; Group 2, 423.8 pounds; Group 3, 442.3 pounds; Group 4, 396.4 pounds.

The cows in Group 1 that raised calves were all in poor condition at the end of the year, eight of them being definitely "creepy." All cows in Groups 2 and 3 remained vigorous and thrifty. Several cows in Group 4 (supplement not increased with calving) became quite thin but no cases of "creeps" developed.

The amount of inorganic phosphorus became very deficient in the blood of all cows in Group 1 that raised calves, often falling below 2 mgms. P per 100 cc. of blood. The level of this element in the blood of the cows in Groups 2 and 3 that raised calves remained practically the same as in that of the dry cows in these groups. A slight deficiency of phosphorus occasionally appeared in the blood of wet cows in Group 4. There were no consistent significant differences in the amount of hemoglobin in the blood of the cows in the check group and in any of the groups that received supplement. There were also no consistent differences in the amounts of inorganic phosphorus or hemoglobin in the blood of the calves from cows in the check group and in that of calves from cows receiving supplement.

The analyses of samples of vegetation collected periodically in the pasture continue to indicate that a serious phosphorus deficiency exists.

L. H. Tash, J. M. Jones, W. H. Black, J. H. Jones.

Mineral and Protein Deficiencies in the East Texas Forest Region

(East Texas Pasture Investigations Laboratory, Lufkin, Texas.)

The study of feeding bone meal and TVA dicalcium phosphate as sources for the supply of phosphorus in self-fed salt licks initiated November 2, 1938, was summarized November 1, 1939. Lot 1 (10 cows) receiving bone meal averaged 1,182 pounds November 2, 1938 and 1,195 pounds November 1, 1939, while the respective weights for Lot 2, receiving dicalcium phosphate, were 1,184 and 1,133 pounds. The average weight difference of 64 pounds per head for the 364-day period is not considered significant

for seven cows dropped calves in the latter group, and only five in the former.

Lot 1 consumed an average of 1.08 ounces of kiln dried salt and 2.16 ounces of bone meal during the test period, while Lot 2 consumed an average of .72 ounce of salt and .32 ounce of dicalcium phosphate. The mixture of 2 parts of bone meal and 1 part of salt was patently more palatable than mixtures of either 25 per cent or 35 per cent of dicalcium phosphate with salt. It was indicated also that the lesser percentage of dicalcium phosphate formed a more palatable mixture than the larger percentage; and neither mixture was nearly so effective in supplying adequate amounts of phosphorus as bone meal. Marked difference obtained in the seasonal consumption of the mineral mixtures, much larger amounts being consumed when the cattle were in declining condition and short of grazing than when the cattle had abundant grazing and were making rapid gains.

A 69 per cent calf crop and difficulty in settling of cows for 1939, together with previous calf crop failures, indicates a serious breeding problem. While part of the breeding difficulty has been traceable to failure of the bulls, other factors may be involved.

J. H. Jones, E. K. Crouch, J. M. Jones.

A Study of Native and Improved Pastures in the Gulf Coast Prairie of Texas

(Substation No. 3, Angleton, Texas.)

This division participated in this project from April 1934 to December 1937. Texas Station Bulletin No. 570, "Pasture Improvement in the Gulf Coast Prairie of Texas," was published in January 1939.

J. H. Jones, R. H. Stansel, J. M. Jones.

Alfalfa vs. Sudan Hay and Ground vs. Chopped Quadroon Heads for Fattening Lambs

(Substation No. 16, Iowa Park, Texas.)

The results of the 97-day feeding trial with four lots of Rambouillet wether lambs indicate that: (1) the grain sorghum heads need not be ground, chopping being sufficient, when fed with choice quality alfalfa hay; but should be ground when fed with medium quality sudan hay; (2) the choice alfalfa hay was worth almost twice as much per pound as the sudan largely because of its value for protein; (3) while the sudan was inferior to alfalfa, it will produce satisfactory gain when calcium and protein supplements are adequate.

Of the 117 lambs marketed, 109 were of prime quality which affords evidence of the excellence of smooth-bodied Rambouillet lambs as feeders.

J. H. Jones, L. E. Brooks, J. M. Jones.

Accuracy of Small Wool Samples for Shrinkage Tests

Work on this problem was continued during 1939. This year's data were obtained from 19 different flocks in Bandera County. All samples were Fine short wools known in the wool trade as Fine Texas 8 months.

The method of selecting the small sample remained unchanged; this method being the taking of a large handful of wool from the shoulder area of each animal at time of shearing. The small samples and corresponding fleeces received identical treatment in scouring and weighing as in 1938.

This year's results compare very favorably with those obtained on 5 similar samples from Bandera County in the spring of 1938. The mean difference in the shrinkage of the small samples and the corresponding fleeces in 1938 was 4.94 per cent, and in 1939 the difference was the same. It was further found that the difference between the mean for the entire fleeces for 1938 and that for 1939 was not significant. The difference between the mean shrinkage per cents of the small samples of 1938 and of 1939 was also found to be significant.

In order to test the practicability of estimating the shrinkages of entire wool clips from the shrinkages of small samples, a correction factor was calculated from the results of the work in 1938. This factor, when applied to the shrinkage figures of the small samples in 1939, gave a standard error of estimate of ± 1 per cent in estimation of the shrinkage of the entire sample from each individual flock.

These results indicate that accurate shrinkage estimations of wool clips may be made by use of a correction factor in connection with shrinkage figures obtained on small samples taken from the wool clips at shearing.

S. P. Davis, J. M. Jones, B. L. Warwick.

ENTOMOLOGY

**Biology, Control, and Taxonomy of White Grubs
(*Phyllophaga* spp.) in Texas**

The life history studies on white grubs (*Phyllophaga* spp.), begun in 1937, were continued during the year. Nineteen species were included in the rearing series for records on the rate of development. Eggs of all species incubated successfully in 6-ounce ointment boxes partially filled with moist sterile sand. About 1,500 newly hatched grubs were isolated separately for developmental records and approximately 80 per cent of this number attained the last larval instar prior to the dormant season. All individuals were supplied with grapenuts as a source of food throughout the period of larval growth. The minimum complete life cycle period recorded was 139 days for *crassissima*; 144 days for *bipartita*; 141 days for *rubricosa*; and 152 days for *calceata*. However, most of the grubs of all species under observation, except *Phyllophaga tristis amplicornis*, are passing the winter in the third or final instar. All larvae of the last mentioned form, which hatched in May, attained full growth and pupated in September and early October. Transformation to the adult stage was completed prior to November.

Grubs carried over from the previous season pupated in the spring or late summer of 1939. The life history observations on *Phyllophaga lanceolata* and *P. crinita* have been completed and submitted for publication. Distributional records, including three species not hitherto known from the State, were secured during the year. The description of one additional new species from Texas has been submitted for publication under the name *Phyllopahga sodalis*.

H. J. Reinhard.

Boll Weevil

(In cooperation with the Bureau of Entomology and Plant Quarantine,
U. S. D. A.)

Except in a few locations, boll weevils were not nearly as injurious as usual. They were present in considerable numbers in upland fields early in the season, but hot, dry weather held them in check as the summer progressed. The numbers increased on new growth in the fall.

Screen traps indicated that the summer migration began about July 20.

F. L. Thomas and J. C. Gaines.

Control: Application of calcium arsenates containing low, intermediate and high water soluble As_2O_3 were again equally effective against the boll weevil when the average infestation on the untreated area was less than 20 per cent. Commercial calcium arsenate gave significantly better control of weevils than a synthetic cryolite. A special calcium arsenate with particles about three times larger than in commercial calcium arsenate

and with more water soluble As_2O_3 produced a higher degree of control and higher yields and appears very promising for weevil control.

J. C. Gaines.

Hibernation: Removal of the active weevils installed in cages as in recent years was begun on April 3, 1939, or about one week after young cotton plants had emerged in local fields. Out of 5,000 weevils installed in cages, 311 or 6.22 per cent survived the winter successfully. The minimum dormant season temperature encountered by these hibernating weevils was 28 degrees F., recorded on November 27, 1938. Emergence extended from April 3 to June 9. Total emergence from all cages by months occurred as follows: April 3.18 per cent; May 2.60 per cent; June 0.44 per cent. For the period 1936 to 1939, inclusive, the average boll weevil survival is 6.27 per cent.

H. J. Reinhard.

Cotton Flea Hopper

(In cooperation with the Bureau of Entomology and Plant Quarantine,
U. S. D. A.)

In general, less damage was caused by the cotton flea hopper (*Psallus seriatus* Reut.) in Texas in 1939 than in many years. Where infestations increased to a point that apparently justified the application of control measures, the injury was of short duration.

Migration and Dispersal: A smaller number of flea hoppers was taken on the screen traps in 1939 than in any year of the 1931-1938 period. The first hopper was captured April 5, and the peak of transfer from weeds to cotton occurred during the week ending May 15, which was about the average date for the 1931-1938 period. The population in general did not increase to damaging numbers except in a few fields.

Flea Hopper Abundance: Although an average of 1,287 adults per 100 sweeps occurred in Croton weeds during one week in the fall of 1938, the population decreased suddenly. There was less opportunity for egg laying, and in the spring of 1939 there was a smaller hatch or emergence than usual. During the fall of 1939 the populations reached a peak of 1,465 adults per 100 sweeps by September 13, but during the next week the population decreased to 616, indicating a low emergence in 1940, from these weeds. The rapid decrease of the population during the latter part of September was due to excessive dry conditions which prevailed over most of Texas. The population was higher and remained higher over a longer period in weeds growing on bottom lands which afforded sufficient moisture for luxurious weed growth.

J. C. Gaines.

Host Plant Studies: The most important early spring host plant of the cotton flea hopper in the vicinity of College Station is the evening primrose, *Oenothera laciniata*. This plant comes up in the late fall and is

common in unplowed fields following corn and cotton. Such fields also have an abundance of *Croton*. When the nymphs which hatch from the eggs overwintering in the dead croton plants appear in the spring they drop to the ground and feed upon the young croton if it is up. Croton, however, in some fields does not come up for two or three weeks after the nymphs appear. *O. laciniata* is commonly present and provides food for the nymphs. Its heavy foliage also protects the nymphs from hard spring rains. Two and four leafed crotons upon which first instar flea hopper nymphs were feeding have been found to be free of nymphs after a shower. Live nymphs have been found on *O. laciniata* after several days of heavy rain. The primrose *O. speciosa* is one of the first plants upon which adult flea hoppers are found in the spring. This plant is widespread and supports at times large flea hopper populations. It is also a plant which increases in abundance after the original vegetation is disturbed. It persists in old fields after croton has nearly disappeared. Immense populations of flea hoppers build up on the flower clusters of the horse-mints *Monarda* sp. This plant and *O. speciosa* are abundant in old fields in both upland and bottom land. *Gaura* sp., a primrose common in old fields in the spring, furnishes a food supply for many flea hoppers.

Croton, the preferred overwintering host plant of the cotton flea hopper, appears suddenly in dense stands in freshly disturbed soil. It varies in abundance according to land use. The average number of *Croton capitatus* plants per acre in the fall in 52 fields under observation in Brazos County for the past six years was as follows: ungrazed grass fields, 111; new terraces, 9,500; fallow 1 year, 16,100; fallow 2 years, 3,600; pasture 17,000; following corn the same season, 7,000; following cotton the same season, 1,700. These studies show that the nearer the vegetation is to the original condition the less croton there is present. Cultivation in corn fields ceases the first of June, giving croton opportunity to come up. On the other hand, cotton is cultivated into August and thus the young croton plants are destroyed as fast as they appear. Intensive grazing by destroying the grass and by the animals' hoofs disturbing the soil also increases the abundance of croton.

R. K. Fletcher.

Varietal Resistance: Four varieties of cotton were planted in a Latin square split plat arrangement, and each whole plat or variety was subdivided into an untreated sub-plat and a sub-plat treated with sulphur for flea hopper control. This experiment was conducted at four locations; namely, College Station, Port Lavaca, Terrell, and Waco. One early, two intermediate, and one late maturing variety of cotton were selected. The two intermediate varieties possessed contrasting characteristics with reference to smoothness and hairiness of the stems. The early and late maturing varieties had higher flea hopper infestation than the intermediate varieties. Although the early maturing variety had about the highest infestation, it also produced the best yield. Since there was very little or no increase in yields resulting from insect control due to hot,

dry weather and shedding on many of the plats, the varieties could not be rated as to their qualities of resistance. The work is to be continued.

J. C. Gaines, S. E. Jones, W. L. Owen, F. L. Thomas.

Strip Planting: Where the maximum infestation in cotton was less than 45 flea hoppers per 100 terminals at Port Lavaca, there was an average of fewer flea hoppers on the first 10 rows adjacent to corn than on the 15th to 25th rows, or on the 50th row from corn. The difference was less pronounced when the maximum infestation was less than 35 flea hoppers per 100 terminals. At Robstown, where severe flea hopper damage occurred early in the season, detailed boll counts made July 10 on fifty feet of row at three points in each of rows 1, 5, 10, 15, 20, 25, and 50 from corn or other talling growing crops on five different farms showed that higher yields were produced on the ten rows adjacent to the tall strip crop (not counting the first row) and lower yields in the rows further removed from such crops. The average numbers of bolls per fifty feet in the rows above indicated were as follows for all five farms: 101, 78, 61, 56, 58, 53, and 41, respectively. Records made in five fields of the Brazos Bottoms showed little difference in the number of flea hoppers on the different rows from corn, when the infestation was low. Boll counts also were about the same. Neither was there any difference in infestation on rows of cotton between strips of corn and sorghum at Terrell in North Texas when there were only 20 flea hoppers per 100 terminals.

S. E. Jones, J. C. Gaines, W. L. Owen, Jr.,
F. L. Thomas.

Relation of Rotations and Fertilizers upon Infestation: Late May planted cotton following winter clover plowed under in early spring was very attractive. The infestation of flea hoppers reached a peak of 108 per 100 terminals on July 28 and averaged 58 over a period of seven weeks and caused severe injury. Where barnyard manure had been applied one time in 1936, 1937, and 1938 to the different fields, the average flea hopper infestation was 16, 34, and 28, respectively, with a maximum record for these fields of 27, 74, and 61 per 100 terminals. Cotton following cotton averaged 38 with a peak of 55 per 100 terminals. All cotton was in the Brazos bottom in fields that were close together, and was planted in March except as otherwise indicated.

J. C. Gaines.

Near Terrell the average infestation in seven fields of upland cotton following cotton was 18 flea hoppers per 100 terminals, in eight fields following corn, 18, and in one field following oats, wheat, and no crop the number of flea hoppers was respectively 27, 22, and 24. In one field where cotton followed cotton, corn, oats, and wheat the infestation averaged 18 following cotton, 17 following corn, 27 following oats, and 22 following wheat. In practically all cases fluctuations toward higher infestations occurred in fields where cotton appeared most succulent.

W. L. Owen, Jr.

Influence of Other Planting Practices upon Infestation: Where two rows of cotton are planted and the third omitted the flea hopper infestation averaged 10 per 100 terminals as compared with 16 in an adjoining field having every row in cotton. In another case where four rows of cotton were alternated with four rows of cowpeas there was an average of 26 flea hoppers as compared with 35 in an adjoining field where every row was planted to cotton. The infestation on late cotton in North Texas reached a much higher peak in August than that on early planted cotton any time during the season.

W. L. Owen, Jr.

Hibernation: Information concerning the time during which the overwintering eggs hatch and the number of young flea hoppers that emerge from day to day is of basic value in anticipating the development of injurious infestations early in the season. Although the cotton flea hopper lays its eggs in a number of different kinds of native weeds, goatwood (*Croton capitatus*) is the preferred host plant. The overwintering flea hopper eggs began to hatch at College Station on March 13, as compared with February 27 in 1938 and February 18 in 1937. The seasonal accumulative emergence recorded at bi-weekly intervals during the spring of 1939 was as follows: March 1-15, 0.15 per cent; March 16-31, 18.81 per cent; April 1-15, 43.24 per cent; April 16-30, 80.89 per cent; May 1-15, 84.92 per cent; May 16-31, 99.81 per cent. Final emergence was noted June 12. The average seasonal emergence was 2,685 flea hoppers per 100 *Croton capitatus* plants. This was less than 50 per cent of normal emergence.

H. J. Reinhard.

Hatching or emergence at Terrell from weeds collected in Hunt, Kaufman, and Van Zandt Counties in North Texas began March 20, as compared with March 14 in 1938 and March 16 in 1937. Fifty-seven per cent of the total emergence occurred during the second week in April, and by the end of the month 88 per cent had emerged. The largest number yet recorded from 100 croton weeds is a hatch of 34,387 from weeds collected in Kaufman County.

W. L. Owen, Jr.

Control: Finely ground sulphur dust (99 per cent passing 325 mesh) and sulphur of microscopic fineness applied both as a dust and by means of a high powered spray machine were tested at Terrell, Lubbock, and Spur. Only the cotton at Terrell became infested to a degree sufficiently high to show a benefit as a result of the applications. All three materials produced a sharp reduction in the infestation. The spray applications applied at a pressure of 300 pounds and under rather adverse conditions gave approximately as good results as the dust applications of finely ground sulphur.

W. L. Owen, Jr.

A series of tests in which ground sulphur, sulphur of microscopic fineness, and a ground sulphur-calcium arsenate mixture were compared

showed no significant difference in the results when the average flea hopper infestations were no higher than 40 per 100 terminals.

J. C. Gaines.

Tests were conducted at Port Lavaca to determine the merits of early dusting to control flea hoppers on land infected with cotton root rot (*Phymatotrichum omnivorum*). The flea hopper infestation was sufficient to warrant control measures in three out of four experimental fields during the latter part of May and in June. Shedding of much of the fruit formed after the last week in June prevented increases as a result of the later applications, but there was an increase in yield of 155 pounds of seed cotton per acre on the plants which were alive at the time of the first picking. All plants which died each week were distinctively marked and the yields recorded for each plat.

S. E. Jones.

Pink Bollworm

(In cooperation with the Bureau of Entomology and Plant Quarantine,
U. S. D. A.)

In spite of the strenuous repressive measures practiced by Federal and State Regulatory Forces, the pink bollworm (*Pectinophora gossypiella* Saund.) not only has increased in the Lower Valley but in 1939 spread to seven additional counties in Southwest Texas and to Tom Green and Mitchell Counties in West-Central Texas. The insect now appears to be firmly established in the Lower Rio Grande Valley, where climatic conditions are more favorable for its development than in the Big Bend area.

F. L. Thomas.

Due to overflows from the Rio Grande River in the fall of 1938 and an early field clean-up, very few overwintering worms were left in the fields, and there was a very light infestation in the 1939 crop.

Tests with cotton varieties in relation to pink bollworm damage again showed that the quicker maturing varieties produced a higher percentage of the crop early in the season under a lighter infestation and therefore were better adapted to pink bollworm conditions than the slow maturing varieties that produced a large percentage of the crop later in the season under a heavy infestation.

Two introduced species of parasites, *Chelonus blackburni* (Cameron) and *Microbracon nigrorufum* (Cushman), were liberated in the Big Bend area of Texas. Although the liberations were made early in the season the breeding period was shortened by floods and an early field clean-up. Due to the adverse conditions it is doubtful if very many of the parasites were carried over the winter. This was the first year for release of *M. nigrorufum* and the second year for large scale releases of *C. blackburni*. Both species have been recovered near points of liberation and are known to live overwinter in hibernation cages at Presidio, but definite information on establishment has yet to be determined.

Studies on pink bollworm survival and emergence under various treatments showed that there was a higher winter carry-over in the heavy adobe soils than in the light sandy soils. The time and rate of moth emergence in the spring was influenced by the temperature and the amount of moisture in the soil. There was a much heavier emergence from larvae overwintering in cocoons on the soil surface than from cocoons buried 2 to 6 inches deep. Of the various cultural treatments tested, deep burial of the larvae early in the winter followed by the application of two winter irrigations was the most effective method of reducing the survival. Experiments conducted to determine the number of worms going into hibernation at various dates in the fall showed that 0.33 per cent of the larvae issuing from green bolls between September 1-15 were long-cycle, 6.96 per cent between September 16-30, and 20.03 per cent between October 1-15.

Field plat insecticide tests using the Latin square arrangement were conducted with arsenicals, fluorines, fixed nicotine, and phenothiazine dusts. Based on the seasonal reduction in worm population the fluorines were the most effective, although the fixed nicotines also gave comparable results. While some of the fluorines have shown promise, satisfactory control with insecticides is still in the experimental stage.

The Arizona wild cotton, *Thurberia thespesioides*, was readily attacked by the pink bollworm when grown in close proximity to heavily infested cultivated cotton. A large number of moths also emerged from larvae overwintering in thurberia bolls that were installed in hibernation cages. Okra became infested in the Lower Rio Grande Valley after cotton was destroyed.

In June a Substation was established at Brownsville, Texas, for the purpose of conducting research studies on the pink bollworm in that locality.

A. J. Chapman, et al.

Cotton Bollworm

(In cooperation with the Bureau of Entomology and Plant Quarantine,
U. S. D. A.)

Biological: About two weeks after the larvae of the corn earworm (*Heliothis armigera* Hbn.), which is the same as the cotton bollworm, enter the soil, the moths begin to seek attractive and succulent cotton plants in order to lay eggs. Therefore, the time when the larvae make exit holes in the corn shucks is of interest in determining when to expect an attack on cotton. The maximum emergence from corn ears occurred the first week in June in Nueces and San Patricio Counties, the second week in June in Refugio, Calhoun, and Lavaca Counties, the third week in June in Fayette, Washington, Brazos, and Burleson Counties, and the fourth week in June in northern Robertson County and in Limestone County. The first increase of eggs on cotton in the Brazos River bottom in Burleson County occurred July 4. As in 1937 and 1938 it occurred on the cotton with the highest per cent of total moisture in the growing top of the plant. While oviposi-

tion was high, 30 to 50 eggs per 100 plants on some cotton following alfalfa, this was not uniformly true, and the highest oviposition, 94 eggs per 100 plants, occurred on cotton following cotton.

Natural Control of Eggs and First Instar Larvae: Over 150 eggs laid on cotton plants were tagged and observed daily. Over 50 per cent of the eggs were destroyed by the hemipterous insect *Orius insidiosus*. At some points this insect accounted for 80 per cent of the eggs. Observations were made on 82 first instar larvae placed on cotton. Approximately sixteen per cent of these were killed by *O. insidiosus*, 25 per cent dropped from the plant, 10 per cent died on the plant from unknown causes, 6 per cent were killed by ants, spiders, and lacewing larvae, and 35 per cent were alive at the end of the day. Nine per cent of the total number of larvae placed on the plants were alive the following morning. These records show the relative importance of a number of factors which sometimes may interfere with the development of an infestation by the cotton bollworm.

R. K. Fletcher.

Thrips on Cotton

The catch of thrips on screen traps and the population in cotton were greater than for any year since 1934. The maximum number recorded on ten plants prior to June 1 was 795. From 15 to 20 per cent of the plants had the terminal buds injured.

J. C. Gaines.

In 1938 counts made of thrips injury to cotton terminals before chopping showed a wide variation in 36 varieties of cotton. The least injured variety showed approximately 22 per cent normal terminals. In 1939, however, similar counts made on the same varieties in the same locality did not agree with those of the preceding year. Varieties having the largest number of uninjured terminals in 1938 did not necessarily have the largest number of uninjured terminals in 1939. This tends to show that there is no difference in attractiveness of the varieties as far as thrips are concerned. Counts were made of the number of thrips present on 6 varieties showing contrasting injury. These counts showed little variation in numbers.

R. K. Fletcher.

Cotton Insect Survey

(In cooperation with the Freeport Sulphur Company)

During the early part of the summer a cotton insect survey was undertaken for the purpose of obtaining definite information concerning the occurrence and abundance of boll weevils and flea hoppers in several sections of the State. Such information which was imparted to the county agents and the press kept the farmers in touch with insect conditions prevailing in 24 counties in South-central, Southeast, North-central, and North Texas. In only a few instances were flea hoppers found in sufficient numbers to recommend control measures. The highest average infestations were found

during the third week in June. Except in Southeast Texas boll weevils did not cause any particular damage after the middle of June, and by the middle of July the survey was discontinued as hot, dry weather held the insect situation well below the danger point. Two men employed on this survey travelled in a personal car and visited 168 different farms from one to three times at an actual cost of \$2.25 per farm visit. The service was free to the farmers.

F. L. Thomas and N. M. Randolph.

Sulphur as an Insecticide

(In cooperation with the Texas Gulf Sulphur Company and the Freeport Sulphur Company)

Progress in this project is reported elsewhere under Truck Crop Insect Investigations and Substations No. 15 and 19; also under Cotton Flea Hopper.

Pecan Insect Investigations

(In cooperation with School of Agriculture, A. and M. College of Texas)

Dormant sprays were applied to pecan trees at Navasota to determine the effect on the overwintering hibernacula of the pecan leaf casebearer (*Acrobasis juglandis* Le B.) Due to the scarcity of hibernacula of the pecan nut casebearer (*Acrobasis caryae* Grote), no data were secured with reference to this insect. Promising results were obtained with low percentages of Dinitro-ortho-cyclo-hexyl-phenol when used in an oil emulsion, in an oil emulsion with bentonite and goulac, in a water spray with bentonite and goulac, and in a water-sodium hydroxide spray. Eight hundredths of one per cent DN in an oil emulsion to 1.3 per cent DN in a bentonite-goulac-water spray were used. Poor results were obtained with a sodium salt of dinitro-cresol, ethylene dichloride emulsion, and emulsions of ortho-dichlorobenzene.

S. W. Bilsing.

Devil's Shoestring, *Tephrosia virginiana* (Linn.), as an Insecticide

(In cooperation with the School of Agriculture, A. and M. College of Texas, and the Bureau of Plant Industry, U. S. D. A.)

Studies on the seasonal and annual variation in the rotenone and total extractives content in the roots of individual plants have been continued another season. No outstanding differences were noted during the growing season. Plants sampled when they were one year of age and again at the end of two years show that the rotenone and total extractive content is greatly increased the second year. In the past it has been difficult to procure seed by tripping the flowers of caged plants. The flowers are ordinarily fertilized by a number of species of wild bees belonging to the family *Megachilidae*. This past spring bees were caught, washed in lukewarm water to remove any adhering pollen, dried, and then liberated on

caged plants. Normal crops of seed were obtained. Cages as small as nine inches in diameter and two feet long were used with success. In larger cages the bees in several instances led normal lives and lived there until the blooming period was over. By the use of these insects satisfactory crops of inbred seed may be obtained. Ten species of this family of insects working *Tephrosia virginiana* have been identified. Inheritance studies are being continued with satisfactory results, but no definite statements can be made at this time. Several plants have been found containing an excess of 5 per cent rotenone.

V. A. Little and G. A. Russell, Bureau of Plant Industry

Truck Crop Insect Investigations

As in recent years the work has been conducted at three locations: the Laboratory at Alta Loma in Galveston County, the Lower Valley Substation No. 15 at Weslaco, and the Winter Garden Substation No. 19 at Winter Haven. Additional information on truck crop insect investigations may be found in this Report under the Substation numbers.

Turnip louse (*Rhopalosiphum pseudobrassicae* Davis): A pyrethrum-sulphur combination containing 0.1 per cent pyrethrins was more quickly effective, but the advantage immediately gained was lost almost as quickly and the infestation practically recovered from the setback it first received. A rotenone-sulphur dust containing 0.5 per cent rotenone was slower in obtaining results, but was more effective in reducing the lice over a week's time, and is to be preferred when the infestation is on the increase. In another experiment in which .5, .75, and 1.0 per cent rotenone-sulphur dusts were used, the 1.0 per cent combination was the only one which was effective.

M. J. Janes.

Sulphur dust applied either directly on cabbage plants or on Harlequin bugs, *Murgantia histrionica* Hahn., had little if any toxicological action. The bugs laid eggs on sulphur dusted plants, and sulphur dusted bugs carried on normal physiological actions. The toxicity of pyrethrum-sulphur dust containing 0.25 per cent pyrethrins was less than half that of rotenone-sulphur dust containing 0.5 per cent or 0.75 per cent rotenone applied either to the bug or to the foliage. The Harlequin bug apparently picks up a lethal dose of rotenone by walking on foliage covered by this dust.

H. Menusan.

Cabbage Looper (*Autographa brassicae* Riley): Comparative tests of full season treatment using a .5 per cent rotenone-sulphur dust indicated that under conditions of a light or moderate infestation of loopers and prospects for a reasonable price, it would be desirable to lighten the dusting schedule in the early part of the growing season and intensify it after the heads begin to form.

M. J. Janes.

Red Spider (*Tetranychus telarius* L.): Red spiders constitute a major problem for strawberry growers in Galveston and Harris Counties. Usually the older plantings become infested first. This occurs in March. Two or three applications of dusting sulphur are very effective in controlling the pest, and no injury is caused either to fruit or foliage, although maximum temperatures were around 80 degrees F.

M. J. Janes.

Citrus Insect Investigations

Work under this subject is presented in the report of Substation No. 15.

Miscellaneous Insect Investigations

Desert Termites Injure Native Range Grasses: Numerous complaints were received during the late summer and fall of 1939 concerning the activity of termites in covering lawn grass with dirt tunnels, particularly in the southern and southwestern parts of the State. In Northwest Texas ranchmen claimed that termites were causing damage to certain native grasses on the range, especially where mesquite growth was abundant. The termites were identified as *Amitermes tubiformans* Buckl. and *Amitermes wheeleri* Desneux and are of the desert type. Preliminary investigation showed definitely that these termites feed on dried and dead grasses and that they will cut off green blades of grass. Soil moisture and air temperatures were the two most important factors governing activity of these insects.

W. S. McGregor and F. L. Thomas.

The Conchuela Bug a Pest of Flax: Heavy infestations of a dark gray stink bug, *Chlorochroa ligata* Say, occurred on flax in the Winter Garden area, the Lower Valley, along the coast and at College Station. This pest of cotton and other crops in the arid and semi-arid areas of the Southwest has greatly extended its range and apparently is an insect that may become a major pest of flax production, particularly in areas where mesquite is present. Preliminary experiments show that the insects are capable of delaying the production of flax and reducing the quantity and quality of the seed. It winters as an adult and requires about a month to develop from egg to adult. The females lay from one to three clusters of eggs averaging about 39 eggs each. Two natural enemies, a tachnid fly *Gymnosoma fulginosa* Desv., which parasitizes 10 to 20 per cent of the nymphs and adults in June, and an unidentified hymenopterous parasite which destroyed approximately 30 per cent of the eggs of *C. ligata* during May are important in controlling the bug in summer.

H. Menusan and F. L. Thomas.

Insects of Ornamental Plants: The leaf crumpler, *Mineola indigenella* (Zeller) is widespread in southern and central Texas. It attacks plums, quince, and the widely planted ornamental firethorn. It is especially injurious to the latter, as it not only defoliates the plant but also renders it unsightly because of the nests of dead leaves formed by the caterpillars.

Preliminary studies show that there are probably three generations of this insect in Texas. It has been successfully controlled with lead arsenate spray.

R. K. Fletcher.

Rose Borer: After receiving numerous complaints regarding borers in roses in the Ft. Worth area, 34 dead rose bushes were collected from that locality and placed in soil in a manner found in plantings. These were installed in cages in October 1938. The first adult emerged May 29 and the last on July 2. A total of 54 borers were recovered. These were determined to be the common flat-headed apple tree borer, *Chrysobothris femorata* Olivier.

W. L. Owen, Jr.

Apiary Inspection, 1939

Migratory beekeepers coming from out of the State continue to increase. Through the cooperation of the beekeepers themselves and the Public Safety Department, the migratory movement has been under control and no outbreaks of American foulbrood have occurred. Work was done in 80 counties, Irion County receiving inspection for the first time. During the fiscal year, 44,953 colonies of bees owned by 793 beekeepers were examined by the inspectors. Among the colonies 515 cases of American foulbrood were found, showing 1.15 per cent infection. Forty-one queenbreeders were granted certificates.

C. E. Heard and W. C. O'Neal.

AGRONOMY

Fertilizers for Field Crops

Fertilizer experiments are being conducted at the Main Station, and at the substations at Angleton and Tyler to determine the fertilizer needs of crops, especially cotton, corn, and oats.

Cotton is used in the experiment at the three stations. At College Station in 1939, the treatments of 12 tons of manure and 400 pounds of superphosphate per acre produced 361 and 369 pounds of lint per acre, respectively, or twice as much as the unfertilized soil. The average yields obtained during the 13 years, however, indicate that the use of 200 to 400 pounds per acre of a 4-6-4, 4-8-4, or 4-12-4 fertilizer has been about equally profitable and is good fertilizer practice for cotton on Lufkin fine sandy loam soil. At Angleton in 1939, the yield ranged from 256 pounds of lint per acre for the unfertilized soil to 485 pounds for the soil that received 800 pounds of an 8-12-8 fertilizer. Considering both yield and profit obtained from fertilizers, however, the use of moderate amounts (400-600 pounds) of a 4-6-4 or 4-8-4 fertilizer, or fertilizer that furnishes similar amounts and ratios of plant food is good fertilizer practice for cotton on the Lake Charles soils.

Corn also is grown in the fertilizer experiment at College Station, Angleton, and Tyler. On Lufkin fine sandy loam soil at College Station in 1939, the treatment of 12 tons of manure and 400 pounds of superphosphate per acre made the highest yield, 42.5 bushels per acre, which is the highest yield produced by any treatment during the 13 years. The average yields for this period, however, indicate that the use of 200 to 400 pounds per acre of a 4-8-4 or 4-12-4 fertilizer is satisfactory for corn. On the heavy, dark Lake Charles soil at Angleton, the treatment of 10-12-4 at 800 pounds per acre produced the highest average yield, 37.5 bushels per acre, for the nine years 1930-39. The results indicate that smaller applications, such as 200 to 400 pounds per acre of a 4-8-0 or 4-10-0, are more profitable for corn on the dark prairie soils of the area. The results obtained on the sandy soils at Tyler indicate that the application of 100 pounds of sulphate of ammonia or nitrate of soda per acre is perhaps the most profitable fertilizer practice for corn, especially where the corn follows a well-fertilized crop such as cotton or tomatoes.

Oats are included in the experiment at College Station only. The yields obtained in 1939 were the highest during the 12 years of the experiment and ranged from 41 bushels per acre on unfertilized soil to 80 bushels on soil that received 800 pounds per acre of a 4-12-4 fertilizer. The average yields for 12 years indicate, however, that the application of 100 pounds per acre of sulphate of ammonia or nitrate of soda to oats in the early spring should be profitable, especially where the oats follow a well fertilized crop as corn or cotton.

E. B. Reynolds.

Comparison of Nitrogenous Fertilizers for Cotton

The purpose of this experiment is to determine the best nitrogenous materials as sources of nitrogen in commercial fertilizers or cotton. The test, consisting of seven different materials, was conducted at College Station in 1939. Due to the dry weather, the fertilizers did not have much effect on yield of cotton. During the last eight years, however, nitrate of soda has made the highest average yield, 277 pounds of lint per acre, or only 12 pounds more than sulphate of ammonia, the next best material.

E. B. Reynolds.

Polyhalite as a Potash Fertilizer

The main purpose of this work with potash is to ascertain if polyhalite, a potash mineral occurring in extensive deposits in western Texas, is a satisfactory source of potash for commercial fertilizers. The test is conducted with cotton Lufkin fine sandy loam soil at College Station. In 1939 the plats that received red polyhalite produced 146 pounds of lint per acre; those receiving white polyhalite, 133 pounds; and those treated with muriate of potash, 127 pounds. For a five-year period from 1933-1939 white polyhalite produced an average yield of 286 pounds of lint per acre,

muriate of potash 279 pounds, and red polyhalite 274 pounds. These yields indicate that water-soluble potash in polyhalite is as readily available to cotton as commercial muriate of potash.

E. B. Reynolds.

Vetch as Green Manure for Cotton

The work with vetch as a green manure for cotton is conducted to get specific information on the yield of vetch and on the effect of plowing under vetch on the soil and on the yield of cotton.

Four treatments and unfertilized soil are included in the experiment at College Station: (1) vetch alone, (2) vetch and 0-8-4 fertilizer, (3) vetch and 4-8-4 fertilizer, (4) a 4-8-4 fertilizer, and (5) unfertilized soil. In 1939, the 4-8-4 fertilizer, used at 500 pounds per acre, made the largest yield, 212 pounds of lint per acre; vetch and 0-8-4 fertilizer 180 pounds of lint, and the unfertilized soil 148 pounds of lint. During the three years 1937-39, the 4-8-4 fertilizer also made the highest average yield, 293 pounds per acre; vetch and 4-8-4 fertilizer, 266 pounds; vetch and 0-8-4 fertilizer, 281 pounds; vetch alone, 225 pounds; and the unfertilized soil, 205 pounds.

In the experiment at Tyler in 1939 vetch plus the 0-8-4 fertilizer produced 301 pounds of lint per acre; the 4-8-4 fertilizer 330 pounds; and the unfertilized soil 215 pounds. For the two years 1938 and 1939 the vetch and 0-8-4 fertilizer yielded 278 pounds, the 4-8-4 fertilizer 287 pounds, and the untreated soil 208 pounds. Where corn has followed cotton on the vetch plots, the corn receiving no fertilizer, the yield of corn for the last three years has been 27.5 bushels per acre, or 10.8 bushels (64 per cent) more than the yield of corn on unfertilized soil.

These results indicate that vetch supplies as much or more nitrogen than either cotton or corn can use to advantage.

E. B. Reynolds, P. R. Johnson.

Plant Introduction

As opportunity permits new plants are introduced and tested at the main Station and substations but no outstanding introductions were found in 1939.

E. B. Reynolds.

Variety Tests of Castor Beans

In 1918 the Texas Agricultural Experiment Station conducted variety tests of castor beans at several points in the State as part of a comprehensive effort in the Southern States to supply the demand for lubricants for airplane engines during the World War. Due to the cessation of the war and to the development of other suitable lubricants, the interest in castor-bean culture lagged and the experimental work with the crop at the Texas Station was discontinued. During the last year or two, however, a renewed interest in growing the castor-bean plant for industrial purposes

has created a demand for more information on the adaptation and yield of the crop in different parts of the State.

In order to get additional information on castor beans, a variety test consisting of four to eight varieties was conducted at Angleton, Beaumont, Beeville, College Station, Iowa Park, Lubbock, Temple, Tyler, and Weslaco in 1939. The average yield of all the varieties was 23 bushels per acre under irrigation and 8 bushels on dry-land at Lubbock, 18 bushels under irrigation at Iowa Park, 16 bushels under irrigation at Weslaco, 16 bushels at Temple, 11 bushels at Angleton, 7 bushels at College Station, and 3 bushels at Beaumont. The highest yield, 37 bushels per acre, was obtained from the flowering variety at Weslaco. When the yields at the several stations are averaged, U. S. D. A. No. 7, Flowering, and U. S. D. A. No. 4 were the highest-yielding varieties, producing 26, 25, and 22 bushels per acre, respectively. It would appear that these are fairly good yields and indicate the possibilities of growing castor beans for seed production under the conditions at the several points.

Yield of green plant material produced by the several varieties of castor beans was obtained only at Lubbock. Under irrigation the Brazilian variety made the highest yield, 15.90 tons per acre, although it produced the smallest yield of seed, which was 14 bushels per acre. The yields of the other varieties ranged from 4.84 tons to 6.57 tons per acre. These yields of green material may indicate the relative possibilities of cellulose production of the varieties.

E. B. Reynolds.

Inheritance in Cotton

(In cooperation with the Bureau of Plant Industry, U. S. D. A.)

Studies were continued during the year on the inheritance and linkage relations of various characters in cotton. The information gained from these studies to date has been of considerable value in the development of improved hybrid strains of cotton at the Main Station and at the sub-stations.

In the studies on the inheritance of fiber fineness, which involves crosses of the fine-fibered Hopi Indian cotton of Arizona with commercial upland types, the Acala and Delfos crosses with Hopi continue to show the greatest promise in the increase plantings, with respect to productiveness and desirable fiber qualities.

The initial crosses between lintless and sparse-linted types and commercial upland varieties were made during the year to determine the possibilities of obtaining desirable recombinations higher in seed and oil production than the standard commercial varieties.

To further test the inheritance of the boll apical furrow character, crosses were made with it and one of the synthetic lines, involving certain boll, lint, leaf, flower, and seed characters.

A paper on the inheritance of green and brown lint colors in cotton has been submitted for publication in the Journal of Agricultural Research.

Segregates obtained from the crosses made in the study of the inheritance of the hirsute or hairy condition of the cotton plant appear promising. Extremely hairy types were recovered which possess high yielding qualities. These will be used in the breeding program to develop high-yielding hairy types of cotton that tend to retain the poison applied in insect control better than ordinary varieties.

The backcrossing work has been completed in the study of the effect of leaf shape and color on yield. Various lines differing only by a single gene in the four gradations of leaf color and one of leaf shape have been isolated for the initial yield tests.

D. T. Killough, T. R. Richmond, R. E. Harper.

Cotton Breeding and Genetics

(In cooperation with the Bureau of Plant Industry,
U. S. Department of Agriculture.)

Classification of over 2,000 progeny of crosses of lintless (lint and seed fuzz absent) and normal (lint and seed fuzz present) stocks, has led to the conclusion that a single gene, *N*, controls both lint and seed fuzz. *NN* plants are devoid of seed fuzz and when modifiers for lint are absent, are also devoid of lint. *Nn* plants carry a trace of seed-fuzz and produce lint approaching in abundance that of the normal *nn* types. The production of lint in *NN* types appears to be conditioned by the presence of plus modifiers. Practical application of the use of modifiers for lint production is being made by combining as many as possible into one genotype which will then be combined with some of the better stocks carrying the major gene for lint production.

An investigation is being made of the possibility of utilizing F₁ hybrids of *G. barbadense* x *G. hirsutum* for the commercial production of cotton with a staple 1½ inches or longer. Small quantities of Upland and barbadense seed were planted in two localities known to have large populations of certain species of Hymenoptera, for the purpose of determining the amount of natural cross pollination between the two species under such conditions and for the production of hybrid seed. The Upland stocks carried markers which facilitated the separation of the natural hybrids from the pure types in the next generation. Seedling tests showed that as an average of all combinations, the amount of natural crossing obtained was nine per cent.

Numerous interspecies crosses were made, and others will be made, to study the practicability of transferring desirable economic characters *G. barbadense*, *G. purpurascens*, and other closely related species to good Upland stocks. This study will parallel a similar one, which has just been

initiated at this Station, in which desirable characters from new species produced synthetically from certain Asiatic and wild species will be transferred to Upland stocks.

T. R. Richmond, R. E. Harper, J. O. Beasley.

Cotton Variety Tests

(In cooperation with the Bureau of Plant Industry,
U. S. Department of Agriculture.)

At Angleton, in the Gulf Coast Prairie, the longer staple varieties were the most profitable ones tested which included Rogers Acala 111, Deltapine (D. & P. L. 11A), Stoneville 5A and 2B, and Delfos 719.

At Nacogdoches and Tyler, on the sandy soil in the eastern part of the State, Rogers Acala 111 and Deltapine were again among the leading varieties, while Mebane (A. D. Mebane Estate), Ferguson 406, New Boykin, Lankart, Rowden (Sunshine and Hurley), and Rhyne's Cook Wilt-Resistant Staple also made a good showing.

Rogers Acala 111 was an outstanding variety in the tests at Greenville, Temple, in the Blackland region, and in Nueces County, and ranked first in money value per acre. It was followed in this respect by Watson, New Boykin, Ferguson 406, Mebane (A. D. Mebane Estate), Lone Star, and Rowden (Sunshine) in about the order named.

The more profitable varieties tested at Denton in the Fort Worth Prairie included Bryant Mebane, Watson, Cliett, New Boykin, and Acala. In the western part of the state the early-maturing strains, Mebane 140 and 141, New Boykin, Ferguson 406, Watson, Mebane (A. D. Mebane Estate), and Northern Star, were leading varieties.

Strains of Acala, Delfos, Deltapine, and Stoneville, which are the longer staple varieties, appear to be well suited to the valley lands and to areas where cotton is grown under irrigation.

D. T. Killough and T. R. Richmond.

Time and Method of Intertillage

Since the work carried under this project is conducted at substation No. 12, Chillicothe, the results obtained in 1939 are given in the report of that substation.

E. B. Reynolds.

Time and Method of Seed-Bed Preparation

This project is conducted at Substation No. 8 and the results obtained are given in the report of that substation.

E. B. Reynolds.

Cotton Improvement

The breeding work which involves straight selection and hybridization followed by backcrossing and inbreeding, has resulted in the development of a number of desirable strains. These include Mebane 804-50, Mebane 804-36, Mebane 140 and 141, Startex 619, and Sunshine 74-2 and 83-3 developed by straight selection, and the hybrid strains Western Early, Half and Half x Lone Star, and Mebane 153 x Lankart. These new strains of cotton are generally proving their value under a wide range of conditions in comparative tests with leading commercial varieties. Particular attention is also being given to the development of strains more resistant to wilt disease and to insect damage. Seed of the proved superior strains developed by the Experiment Station are being increased as rapidly as possible on cooperating farms, and some have been put into channels of commercial production through state certified seed breeders and others so that the seed may be readily available to the cotton producers of the State.

D. T. Killough.

The Spacing of Cotton

The main purpose of this experiment on the spacing of cotton is to ascertain if the spacing of the plants needs to be different on soils of different levels of fertility. In order to get specific information on this point cotton plants are spaced 12, 18, and 24 inches apart in 3-foot rows on unfertilized soil and on soil that receives 400 pounds and 800 pounds of 4-8-4 fertilizer per acre. In 1939 as an average of all the soil treatments, the 12-inch spacing produced 315 pounds of lint per acre; the 18-inch spacing, 281 pounds; and the 24-inch spacing, 286 pounds. For the four years 1936-39, the 12-inch spacing produced an average yield of 272 pounds of lint per acre, the 18-inch spacing 251, and the 24-inch spacing 245 pounds. When the yields of the three spacings for the four years are averaged, the unfertilized soil produced 196 pounds per acre; soil that received 400 pounds of fertilizer, 273 pounds; and soil that received 800 pounds of fertilizer, 298 pounds. The results of this fertilizer-spacing test are in general agreement with the results of previous work on spacing, published in Bulletin No. 340 several years ago.

E. B. Reynolds.

Rice Improvement and Methods of Production Tests

The work carried under this project includes (a) breeding and selection of rice, (b) testing of varieties and new strains developed, (c) use of fertilizers, including different kinds and rate, time and method of application, (d) rate of seeding, (e) irrigation, and (f) investigations of diseases, especially the black kernel disease. Since the work is conducted at Substation No. 4,

and in cooperation with rice growers in the rice-producing area, the results obtained in 1939 are given in the report of Substation No. 4.

R. H. Wyche, H. M. Beachell.

Soil and Water Conservation

(In cooperation with the Soil Conservation Service,
United States Department of Agriculture.)

The Soil and Water Conservation studies are conducted at the Spur, Temple, and Tyler stations and the results are given in the reports of these stations.

Pasture Improvement and Management in East Texas

This pasture work consists largely of the practical phases of improving and managing the pastures on the substation farms at Substation No. 2, Tyler, and Substation No. 4, Beaumont. The results for the current year, 1939, will be found in the reports of these stations.

E. B. Reynolds.

Breeding Cotton for Mechanical Harvesting

(In cooperation with the Division of Agricultural Engineering)

In this work at College Station and at Lubbock, it was found that certain boll and fiber characteristics as well as type of plant materially affect the cleaning qualities and consequently the grade of cotton harvested by machinery. The cleaned lint of the medium-staple varieties with coarser-bodied fiber and compact boll type was comparatively free of leaf and bract thrash and graded higher than the cleaned lint of the longer-staple, finer-bodied varieties which often contained a considerable quantity of such thrash. The differences in some cases amounted to as much as two grades in favor of the medium-staple varieties with coarser-bodied fiber. Varieties having large plants and abundance of foliage were harvested with greater difficulty than varieties with a smaller, more compact type of plant. Varieties with large, relatively storm-resistant bolls were harvested with greater ease, and the lint graded higher as compared with small-boll varieties in which the cotton was inclined to hang out of the bur.

A number of new crosses were made during 1939 between certain varieties with the view of producing strains which combine those characteristics found to be most suited to mechanical harvesting. Hybrid strains which have recently been developed and which show promise in harvesting trials include Western Early, Ducona x Lone Star and Ducona x Half and Half.

D. T. Killough, H. P. Smith, D. L. Jones.

Variety Test of Soybeans

This test, consisting of 14 to 20 varieties, has been conducted at the Main Station at College Station and at the substations at Angleton, Beeville, Denton, and Tyler during the last four years. The varieties are planted at three dates, early, medium, and late. During the four years 1936-39, the average yields of seed of all the varieties have been low or practical failures at all dates of planting at all of the substations.

At Angleton in 1939, the Laredo variety made the highest individual yield, 7.9 bushels of seed per acre. At Denton in 1939, Manchu produced 10.5 bushels of seed per acre and Macoupin 10.3 bushels. Manchu has been the highest yielding and most consistent variety, making an average yield of 8.6 bushels for the four years 1936-39.

The results of the tests with varieties of soybeans at the five points indicate that the varieties tested are not adapted for seed production in Texas.

E. B. Reynolds, R. H. Stansel, R. A. Hall, P. R. Johnson, P. B. Dunkle.

Germination and Longevity of Bitterweed Seed

After conducting this work five years, 1931-36, it became necessary to discontinue it because the seeds stored in the open and exposed to the weather at the Ranch Station, Sonora, had deteriorated and rotted to such an extent that it was not possible to get satisfactory samples for germination. The viability of the seed stored outdoors, however, decreased from 72 per cent to less than 1 per cent during the five years.

V. L. Cory, W. H. Dameron, E. B. Reynolds.

Inheritance and Improvement in Sorghums

Breeding of sorghums for resistance to *Pythium* root rot has resulted in the development and distribution of three new resistant varieties: Texas Dwarf Yellow milo, Texas Double Dwarf milo, and Darso No. 28. These new varieties have entirely replaced the old susceptible types formerly grown by the certified sorghum seed growers. The *Pythium* root-rot organism is now widely distributed in Texas soils and ordinary milo yields are very much reduced. At Lubbock on diseased land in 1939 the old susceptible Dwarf Yellow milo yielded 8.3 bushels and the new resistant variety Texas milo yielded 25.7 bushels to the acre. At Chillicothe in 1939 six susceptible varieties yielded only 37 per cent as much grain as the six new disease-resistant strains developed by the Texas Station.

Charcoal rot (*Sclerotium bataticola*) damaged sorghums at Lubbock and Chillicothe and was again prevalent over the western part of the State. Damage was less severe on sorghums planted under irrigation at Lubbock. This disease causes decay in the lower part of the stalk and the plants fall before the heads are dry enough to harvest. All varieties appear to be susceptible to this disease and resistant strains have not yet been developed.

The aim of the breeding work with Sudan grass is to produce a strain that has non-shattering seed habits, stems that are sweet and juicy, resistant to the common foliage diseases, and with distinctive glume color that will cause the seed of the variety to be recognized at a glance and will allow a freedom from Johnson grass contamination to be recognized by casual inspection. This is the first year all the desirable qualities have been combined in a single strain. Among approximately 300 selections made in 1939 are some that should produce progenies in 1940 suitable for increase and distribution. Part of each progeny that has been grown in the past two seasons has been grazed by cattle. Certain strains have been definitely more palatable and certain others less palatable than the average. The preference of the cattle has been recognized in making selections. Grazing experiments with beef cattle at Beeville and with hogs at College Station showed marked preference of livestock for many of the improved strains over the common Sudan grass. The characteristics of sweetness and juiciness of stem, non-shattering seed habit, foliage disease resistance, and sienna glume color were obtained from Leoti sorgo which was used as a parent. The breeding work has consisted of backcrossing to Sudan grass several times and finally intercrossing of strains with the necessary work of selection after each hybridization.

The development of Blackhul kafir and Yellow milo varieties having sweet stems and higher forage value is nearing completion. Other sorghum breeding projects under way are incorporating the yellow pericarp color into varieties of hegari, kafir, and feterita, and breeding palatable white- and yellow-seeded varieties of sorgo resistant to leaf spot diseases. Early hegari, apparently the result of mutation in ordinary hegari, appears to be a valuable addition to the list of varieties grown in Texas. This new strain is about 15 days earlier than hegari, produces an abundance of palatable forage and made good yields of grain at some of the substations when the parent variety failed to head.

Inheritance and linkage relation of numerous characters in sorghum continue to be studied.

One phase of the genetics studies was greatly expanded in 1939. It was recognized late in the season of 1938 that certain F_2 populations whose parents were commercial varieties were segregating for maturity in relatively simple Mendelian fashion. Plantings of F_2 populations involving Early White milo, Dwarf Yellow milo, Day milo, Blackhul kafir, feterita, hegari, honey, broomcorn, Leoti, and several other varieties of hybrid origin were made in 1939. Plants in these populations as well as plants of the parental varieties were tagged for date of first bloom and a tabulation of the blooming date of each plant in the numerous populations reveal clearly that the different maturity and behavior of the parents has a genetic basis. Some varieties such as Early White milo and Dwarf Yellow milo apparently differ by a single gene. Certain other crosses involve parents that appear to differ by two genes while others indicate a difference of

at least three genes between the parents. When the parents differ by as many as two physiological genes there is an overlapping of the classes for date of bloom and the correct classification must await identification of the genetic constitution of each plant by growing the F_3 generation. The work has progressed to the point, however, where it is clear that physiological plant responses are genetic.

The full import of the role of such genes in the behavior of plants under different environments has not been understood or appreciated. They apparently account for the major varietal differences found in sorghums and are the genes governing varietal adaptation. It appears certain also that the major part of the hybrid vigor encountered in certain sorghum crosses can be accounted for by the heterozygosity of a few genes which govern physiological adaptation.

R. E. Karper.

Effect of Fertilizers on Yield, Chemical Composition, and Botanical Composition of Pasture Herbage

(In cooperation with the Tennessee Valley Authority)

This work was started in the spring of 1936 and is conducted at College Station, Angleton, Lufkin, and Tyler.

On Lufkin fine sandy loam soil at College Station in 1939 the treatment consisting of 40 pounds of nitrogen and 80 pounds of phosphoric acid (in TVA triple phosphate) per acre made the largest yield, which, however, was only 1,385 pounds of air-dry forage per acre. Although applications of both nitrogen and phosphate have produced small average increases in the yield of forage during the four years 1936-39, it is doubtful if their use has been profitable.

On Bowie fine sandy loam at Tyler in 1939, the treatments consisting of (a) 40 pounds of nitrogen and 40 pounds of phosphoric acid per acre, (b) 40 pounds of nitrogen and 80 pounds of phosphoric acid, and (c) 40 pounds of nitrogen, 80 pounds of phosphoric acid, and 40 pounds of potash, produced 2,700, 2,956, and 2,849 pounds of air-dry forage per acre respectively. These yields are twice as large as the yield from the unfertilized pasture in 1939 and for the three years 1937-39. The results indicate that fertilizers are profitable for pastures in the area.

At Lufkin on Caddo fine sandy loam soil, applications of phosphoric acid and potash made larger increases in yield of forage than applications of nitrogen.

The results obtained at Substation No. 3, Angleton, are given in the report of that station.

E. B. Reynolds, G. S. Fraps, R. L. Hensel, J. H. Jones.

Improvement of Range and Pasture Plants

The 1,200 buffalo grass plats are well established and comprehensive notes have been taken on them for 2½ years. Some plants in the different strain groups have been outstanding from the beginning and have been used as parents in making 271 different crosses. Certain plants are superior in drought resistance, cold-hardiness, and seed production, forage production, and disease resistance. Seed have been collected and planted from 70 such promising pistillate plants.

Chemical analysis shows the Encinal strain to be the highest in calcium and the lowest in phosphoric acid and protein. The Chillicothe strain was highest in phosphoric acid and protein. One of the perfect-flowered buffalo grass plants found last year produced 19 seeds. From these seed seven plants were produced, which are growing in the nursery, but have not yet bloomed.

The row tests of different species of grasses and clovers have been continued. Seed were collected from 47 different species of grass. At the present time the grasses showing greatest promise are yellow beard grass (*Andropogon ischaemum*), Angleton grass (*Andropogon annulatus*), *Panicum antidotale*, *Paspalum malacophyllum*, and Haddon's grass. *Andropogon ischaemum* seedling plants and culms of older plants were set out in 1,500-foot rows in the nursery.

It has been generally assumed that Angleton grass does not set seed in this country, but observations made in the nursery show that the heads which were produced this year contained viable seed. It was noted further that these seeds do not require a resting period as they will germinate as soon as they are mature. Seed from the various plants have been harvested and will be planted with the object of selecting desirable strains for further study. Large quantities of stolons were cut into pieces 18 to 24 inches long and layered into 1,200-foot rows September 15 and watered once. Approximately 85% of the cuttings rooted, producing about 35,000 rooted cuttings. Seed heads from these cuttings were clipped December 20, and will yield approximately 5 pounds of seed.

Plants of Angleton grass, yellow beard grass, and various species of *Chloris* were taken into the greenhouse for crossing work, but the high humidity in the greenhouse has been detrimental to the production of pollen and favorable to the development of fungous diseases.

Seed from the 26 types of rye grass selected last year were planted. These seeds were open-pollinated, and there was some variation within types. Marked differences in time of setting seed and disease resistance were still present. A plat of centipede grass approximately 700 square feet has been established to observe its possibilities as a lawn grass. A similar plat of St. Augustine grass was put in to observe its susceptibility to

various disease and insect pests and to observe the effect of different fungicide and insecticide treatments used.

R. L. Hensel, George C. Warner.

Limiting Factors in Pasture Production

The cooperative experiments with the United States Department of Agriculture, which were designed to test the effect of certain fertilizer combinations applied directly on established sod to the growth of white, Persian, low hop, least hop, cluster, and subterranean clovers, were a failure due to the fact that the area selected for the test contained so much bur clover that the other clovers were shaded out and were unable to make satisfactory growth. In an effort to determine whether white, Persian, and hop clovers would do well in this section, field plantings with 100 and 200 pounds of superphosphate per acre were made during the fall on the Sullivan ranch where livestock are available.

Further cuttings of the dairy farm fertilizer plats continue to indicate that application of fertilizer to the sod does not significantly increase the yield of Bermuda grass.

Studies on spread of mesquite and prickly pear are being continued at the Texas Range Station, Ozona. Tabosa grass (*Hilaria mutica*) in west Texas has spread through improper management and heavy grazing to the extent that it is crowding out the more desirable grasses such as buffalo and curly mesquite.

In order to ascertain the effect of burning on the control of this grass, a small area was burned in September 1938. Subsequent inspections showed that livestock grazed this area very closely, grazing both the short grasses and the tabosa. To test the effect of mowing on tabosa grass, approximately 6 acres were mowed in September. Large amounts of this cut grass were eaten by the cattle in preference to the uncut grass. Observations on the vegetation following this mowing will be made this spring.

R. L. Hensel, George C. Warner.

Management of Grazing Lands

At the Lufkin station plans were made in the early spring to change from an 8-pasture rotation to a 4-pasture rotation, leaving 2 pastures for hay and reserve. The other 2 pastures were to be handled in such a way that the present carpet grass would be changed to a cover of dallis grass which would be more desirable since this grass is more drought resistant and nutritious than carpet grass. Due to drought during the entire summer this plan had to be abandoned, as it was necessary to graze the livestock on all the pastures to maintain them in good condition. In order to provide additional winter grazing, 30 acres of upland pasture, consisting largely of Bermuda grass, were fenced and super-

phosphate at the rate of 300 pounds per acre was disked in. In late spring common lespedeza was sown on this area but due to dry weather, it failed to germinate.

The University of Texas range land, located at Ozona, which has been assigned to the Experiment Station for cooperative experiments, has been named the Texas Range Station. Observations are being made on the best way to combat bitterweed, *Actinea odorata*, either through different systems of management or through cultural methods, or both. Records of the condition of the range under different systems of management have been made from vegetative counts of 96 stations. Nine of these plant-count stations were added in September 1939 to include more bitterweed hazard areas.

The long dry winter caused most of the bitterweed seedlings which had germinated the previous summer to die before producing seed. As a result the range is now comparatively free of bitterweed.

The 900 pounds of seed of rescue grass, Italian rye grass, alfilaria, oats, and fenugreek, which were planted on hazard areas in Pasture C in 1938, did not come up to a stand due to the long dry winter. This year, however, there was ample moisture and the areas sown in 1938 showed germination of some rescue grass and alfilaria.

During the first part of September 1939, over 1,000 pounds of rescue grass, rye grass, alfilaria, and fenugreek seeds were sown in hazard areas. Due to favorable moisture conditions, all of these were up to a good stand and appeared very promising in December.

The tabosa grass-curly mesquite area which was burned in September 1938, showed less tabosa grass and also less curly mesquite. A tabosa grass plat of approximately 6 acres was cleared of trees and prickly pears and mowed on September 5, 1939. The cattle in this pasture consumed fair amounts of the mowed tabosa grass before it was completely cured.

In order to ascertain the proper rate, time, and method of sowing buffalo grass seed, 5 small plats were sown in December at the rate of 5, 8, 11, and 14 pounds per acre. One half of each plat was disked and the other half was undisturbed.

R. L. Hensel, George C. Warner.

Cytogenetics and Improvement in Cotton

Work was begun on this project September 1, 1939. Several species and hybrids of *Gossypium*, hybrid seeds, induced polyploids, and seeds of polyploids were transferred in October and November from the United States Department of Agriculture, Bureau of Plant Industry, Cotton Fiber Laboratory, Raleigh, North Carolina, to the Texas Agricultural Experiment Station.

Polyploids were produced from hybrids of 26-chromosome, *G. hirsutum* L. x 13-chromosome *G. anomalum* Wawra. and Peyr.; of 13-chromosome

G. arboreum var. *neglectum* Hutchinson and Ghose. x *G. anomalum*. A study of the meiotic chromosome behavior of *G. hirsutum* x *G. anomalum* gave an average of about eight parts at first metaphase, and most of the pairs became attenuated at first metaphase. The attenuated chromatin structures were interpreted as chromosome bridges, which resulted from structural differences of paired chromosomes. These observations are evidence that structural differences exist between most of the chromosomes. A cytological study of the hybrid *G. arboreum* var. *neglectum* x *G. anomalum* gave evidence that several differences in chromosome structure exist between the two species.

Haploids, from which pure lines can be produced, have been found in Acala and Stoneville strains of cotton. Attempts to find them in a few other upland strains have failed.

More than a dozen haploids of *G. Barbadosense* and *G. hirsutum* have been X-rayed in order to produce gene mutations and structural changes in their chromosomes.

J. O. Beasley, T. R. Richmond.

Flax as a Winter Crop in South Texas

(In cooperation with the Bureau of Plant Industry, U. S.
Department of Agriculture.)

Experiments in the production of flax as a winter crop in South Texas have been highly successful for the fourth consecutive year. As a result of the mild winters, no winter-killing occurred in any of the varieties grown at College Station, Angleton, Beeville, and Winter Haven during the winter of 1938-39. In a special winter-hardiness nursery grown on several of the more northern substations, one variety, Roman Winter, survived as far north as Substation No. 6 at Denton, which suggests the possibility of ultimately extending the production of winter flax well up toward the Oklahoma border. The Rio variety has continued to show somewhat more promise than most of the other varieties.

The experimental plantings of flax on the experiment stations of South Texas have created a great deal of interest in the crop among farmers, as a result of which about 20,000 acres of the crop were seeded on farms in the Gulf Coast region in the fall of 1938. In spite of having experienced one of the driest growing seasons on record, fair to good seed yields were obtained except in the area to the north and west of Beeville where only one rain of value was received during the growing season.

E. S. McFadden, Bureau of Plant Industry, P. C.
Mangelsdorf.

The Use of Growth Promoting Substances for the Treatment of the Cotton Plant

Studies were started in the fall of 1938 to determine the effect of growth promoting substances on the rooting of stem cuttings and root

stocks of cotton. Each individual plant was subdivided into a rootstock and several stem cuttings following the harvest of its current seed crop. A rootstock included approximately four inches of the taproot as well as some stem tissues while the stem cuttings consisted of three node pieces of mature, semi-mature, and soft wood of the main stem and vegetative branches. All lateral appendages, except leaf buds, were removed from each rootstock and stem cutting. As previously reported, the treatment of the basal portion of the rootstocks and mature stem cuttings with indolebutyric acid in aqueous solution of 100 parts per million for 18 hours prior to placing them in moist sand resulted in profuse root development within six weeks. Several hundred of these rooted pieces were transplanted to the field in the spring of 1939 and their subsequent development was very similar to that of normal mature plants developed from seed.

During 1939 additional rootstocks and stem cuttings were treated with indolebutyric acid solutions and the results secured were similar to the results secured in 1938. As the result of the two seasons' work, an average of 93 per cent of the rootstocks and of the mature stem cuttings treated with indolebutyric acid in an aqueous solution of 100 parts per million rooted profusely within six weeks, while only 61 per cent of the untreated rootstocks, and 43 per cent of the untreated mature stem cuttings produced even mediocre root systems. Results secured in 1938 and 1939 indicate that semi-mature wood is not as acceptable as mature wood, although it may be used with moderate success. Soft wood cuttings failed to root satisfactorily in both years.

H. E. Rea.

Inheritance and Improvement in Corn

As a result of the increasing sale of Corn-Belt hybrid corn in Texas, it became necessary in 1939 to conduct an extensive test of Corn-Belt hybrids at College Station and the substations. Most of the hybrids which are commercially available in Iowa and Illinois were included. At no place where tests were conducted except in North-Central Texas, represented by Substation No. 6 at Denton, were the Corn-Belt hybrids significantly more productive than the better open-pollinated native varieties. Tests with a smaller number of Corn-Belt hybrids will be continued; in the meantime, none can be recommended for those parts of Texas where ear worm and weevil damage is an important factor.

Although none of the Corn-Belt hybrids tested was completely satisfactory in Texas, some of the inbred strains used in Corn-Belt hybrids show considerable promise. A number of the better inbred strains have been crossed with Yellow Surcropper and will be backcrossed to the inbred parent to produce modified strains which are suitable for use in Texas.

The development of hybrid field corn for Texas has proceeded satisfactorily. Two inbred strains of Mosshart Yellow Dent, 127C and 132A, which

produce increases in yield of 28 and 42 per cent, respectively, when crossed with Yellow Surcropper, have been increased and approximately seven acres will be devoted to crossing these strains in 1940. The single cross of these two strains, seed of which should be available for distribution in the fall of 1940, can be used as a pollinator for Yellow Surcropper to produce a top-cross yielding approximately 35 per cent more than Yellow Surcropper. It is possible that this single cross will also combine well with one or more of the Corn-Belt single crosses which are already commercially available. This possibility is being tested and if it proves successful the production of an early maturing yellow-seeded double cross can begin in 1941.

Four inbred strains of white corn which can be combined to produce an excellent white-seeded double cross are being increased and stock seed should be available for commercial production in 1941.

New inbred strains of Yellow Surcropper and Golden June are being isolated for combining with strains 127C and 132A.

Sweet corn breeding is largely confined to the isolation and testing of yellow-seeded inbred strains derived from crosses of P39 and P51 with various Texas sweet corn varieties. Some of these strains are very promising, exhibiting considerable vigor and resistance to ear worm damage and at the same time possessing an excellent quality. The more promising strains have been combined in single crosses which will be tested at Weslaco, Winter Haven, and College Station in 1940.

The results of testing hybrids in 1939 and a summary of the variety test results for the past ten years has been published as Progress Report No. 657.

P. C. Mangelsdorf.

The Genetic and Cytological Relationship of *Zea*, *Tripsacum*, and *Euchlaena*

(In cooperation with School of Arts and Sciences, A. & M. College of Texas)

Further studies on chromosome knobs of South American varieties have shown that the majority of varieties from Peru, Bolivia, and Ecuador have knobless chromosomes. This supports our previous suggestion that the Andean region, probably the primary center of domestication of maize, is the principal region where pure maize has not been largely replaced by *Tripsacum*-infected varieties. If this is true most of the stocks of North American maize with which the majority of genetic and cytological studies are conducted are probably polyploid for certain regions of the chromatin. This may account for the fact that some very minute deficiencies are quite deleterious while other larger deficiencies have no appreciable effect.

There seems to be a possibility that a wild or feral type of maize is still in existence in Paraguay. A botanical collector in Paraguay has sent us a specimen of a maize plant which he claims to have found

growing in a colony in a clearing in the forests. The specimen was small and earless but bore at the base of the unbranched tassel, pistillate spikelets enclosed in glumes. It differed from stunted corn in having the staminate and pistillate portions of the inflorescence distinctly separated. Seed of this peculiar type has not yet been obtained but seed from a variety cultivated by the Guarany Indians in the same general locality produced plants with knobless chromosomes. This is the first variety of maize with knobless chromosomes obtained from the lowlands of South America. On the basis of our hypothesis we should expect wild maize to have knobless chromosomes.

Additional linkage studies in crosses of Florida teosinte with various genetic stocks show that translocation segment A is located on chromosome 4, and shows linkage with *su* and *gl*. Segment B is located on chromosome 1 showing fairly close linkage with P and a slight indication of linkage with *bm*. Segment C shows linkage with genes on 4, 6, and 10, the closest linkage being with 10. Segment D appears to be located on chromosome 9 and shows linkage with *wx*.

When Chalco and New teosinte are crossed the F₁ hybrid has paired pistillate spikelets although both parents have unpaired spikelets.

Florida, Durango, Nobogame, and New teosinte have been crossed with a uniform inbred strain and the F₁ hybrid backcrossed to the same strain to obtain populations in which all genetic variation is due to segregation of genes from teosinte. These populations show that the major part of the segregation is due to the four blocks of genes or translocation segments which we assume to have been derived from *Tripsacum*. Durango has the same four segments found in Florida, but they have less effect which suggests that they may be smaller and contain fewer *Tripsacum* genes. Nobogame teosinte contains only three of the four segments found in Florida and Durango teosinte. All of the data support our assumption that the Guatemalan teosintes represent the primary products of the hybridization of *Zea* and *Tripsacum*, while the Mexican teosintes are secondary or tertiary products.

The results of investigations in connection with this project were published in 1939 as Bulletin 574, "The Origin of Indian Corn and Its Relatives".

P. C. Mangelsdorf and R. G. Reeves.

Breeding Wheat and Oats for Resistance to Rust

(In cooperation with the Bureau of Plant Industry, U. S.
Department of Agriculture)

Breeding work on developing rust resistant varieties of wheat and oats for South Texas has reached a point where several promising rust resistant wheat selections from the Hope x Mediterranean cross are now being increased in field plots on the Temple substation. Milling and baking

tests on the two most productive selections indicate that they are suitable for bread making.

Two promising strains of oats from the cross Nortex x Victoria that carry resistance to crown rust combined with winter growth habit and good kernel type are being increased in field plots at Temple and College Station for distribution this coming fall. Some 3,000 strains of oats selected for resistance to both stem rust and crown rust have been reduced to 128 strains which are now growing in duplicate single rod-row nurseries at Weslaco and College Station. The more promising selections will go into a replicated nursery next fall.

To develop rust resistant strains for North Texas and other states, to serve as a barrier against the spread of rust, several hundred rust resistant selections made from crosses between Hope x Mediterranean and northern commercial varieties of winter wheat are being tested in head-rows at College Station this year. The more promising of these will be distributed to experiment stations in Oklahoma, Kansas, Arkansas, and Missouri this fall.

The prevalence of both stem and leaf rust render South Texas an ideal place for the testing of rust resistance under natural conditions. During the past year we have cooperated with stations in Minnesota, North Dakota, South Dakota, Colorado, Kansas, and Nebraska in testing wheat breeding material for resistance to stem and leaf rust. Foreign wheats have also been extensively tested and about 20 wheats among several thousand foreign wheats tested have been found to have varying degrees of resistance to stem rust, and have been disseminated to other wheat breeders for use as parental material.

An attempt is being made to combine seedling immunity to all forms of stem rust found in certain Kenya wheats and McMurachy with mature plant resistance and winter type of growth found in Hope x Mediterranean selections. This material is now in the F_2 and F_3 generations.

Crosses of Hope with Martin, Ridit, and White Odessa have given strains well adapted to Central Texas that carry resistance to stem rust, leaf rust, loose smut, and bunt. An attempt is now being made to combine these factors with seedling immunity to all forms of stem rust found in McMurachy and the Kenya wheats.

The following technical paper was published: "Brown Necrosis, A Discoloration Associated with Rust Infection in Certain Rust Resistant Wheats", Journal of Agricultural Research, Vol. 58, No. 11, pp. 805-820.

E. S. McFadden, Bureau of Plant Industry, P. C. Mangelsdorf.

MAIN STATION AGRONOMY FARM

The Main Station Agronomy Farm is located on the land of the Agricultural and Mechanical College of Texas at College Station, Brazos

County. The station comprises 101 acres of land, 76 acres of which are used for experimental purposes and the remaining acreage for buildings, pastures, and roadways, and for the production of seed of superior strains of crops on the farm for distribution to farmers. A large percentage of the land is made up of Lufkin fine sandy loam soil.

Rotation and Soil Improvement Investigations

In this series of experiments only the non-rotation test with cotton, has been continued. This test consists of ten plats, some of which receive no treatment, one plat receives no treatment and has the crop residue removed, and others receive superphosphate, rock phosphate, manure, manure and superphosphate, manure and rock phosphate, and manure and cottonseed meal.

During the 26 years, (1914-39), those plats receiving manure, either alone or in combination with superphosphate or rock phosphate have made the greatest yields. The treatment of manure alone produced 239 pounds of lint cotton to the acre, manure and rock phosphate produced 228 pounds, and manure and superphosphate produced 214 pounds.

Fertilizer Experiments

The object of this test is to determine the fertilizer needs of cotton, corn, and oats on the Lufkin fine sandy loam soil. The test consists of a three-year rotation of cotton, corn, and oats in which a 4-12-4 fertilizer at the rate of 400 pounds to the acre is used as a standard treatment. Then each element—nitrogen, phosphoric acid, and potash—is varied in turn, while the other two are kept constant. The 4-12-4 fertilizer is also used at rates of 200, 600, and 800 pounds to the acre.

Cotton: For the thirteen-year period, (1927-39) the treatment of 12 tons of manure and 400 pounds of superphosphate to the acre produced the highest yield, 376 pounds of lint cotton to the acre or 160 pounds per acre more than the average of the plats which received no treatment and 72 pounds per acre more than the average of the five check plats which received 400 pounds of 4-12-4 commercial fertilizer to the acre. The treatment of 12 tons manure per acre produced the second greatest yield, 355 pounds of lint cotton to the acre.

Corn: For the same period of years the three treatments producing the greatest yields were: 12 tons manure and 400 pounds superphosphate, 31.7 bushels shelled corn to the acre; 12 tons manure, 29.5 bushels; and 8 tons manure, 29.2 bushels. The yield of the one untreated plat was 22.2 bushels shelled corn to the acre, or 9.5 bushels per acre less than the highest yielding treatment.

Oats: During the same 13-year period, the three treatments producing the greatest yields of grain were: 800 pounds of 4-12-4 fertilizer, 32.3

bushels to the acre; 600 pounds of 4-12-4, 31.0 bushels; and 400 pounds of 6-12-4 fertilizer, 29.8 bushels. The average yield of the five check plats which received 400 pounds of 4-12-4 commercial fertilizer to the acre was 26.9 bushels, and the untreated plat produced 22.5 bushels or 9.8 bushels per acre less than the highest yielding treatment.

Source of Nitrogen and Potash Test

This experiment is conducted to determine the relative merits of different nitrogenous and potash materials as fertilizers. Each fertilizer treatment is an application of 400 pounds of 4-8-4, but the nitrogen and potash in each fertilizer is supplied by different materials. White polyhalite, as a potash material found in extensive deposits in Western Texas and New Mexico, produced a yield of 311 pounds of lint cotton to the acre over a five-year period, or 9 pounds per acre more than muriate of potash which is the principal source of potash in commercial fertilizers. These results to date indicate that the soluble potash in polyhalite is as readily available to cotton plants as the potash in muriate of potash.

Of the nitrogenous materials tested, ammonium nitrate produced a yield of 314 pounds of lint cotton to the acre and sodium nitrate produced a comparable yield of 298 pounds.

Cotton Variety Test

This test in 1939 consisted of 54 varieties randomized in six replications and of those varieties the three highest-yielding varieties were: D. & P. L. 11A, 253 pounds of lint cotton to the acre; D. & P. L. 12, 251 pounds; and Rowden 41B, 239 pounds.

On the basis of comparable yields among those varieties that have been grown for 10 years or longer, the three highest-yielding varieties are: Ferguson 406, 261 pounds of lint cotton to the acre; New Boykin, 244 pounds; and Sunshine 238 pounds. Startex 619, a selection developed on the Main Station Farm, has been grown for the past nine years and has a comparable yield of 233 pounds.

Spacing and Fertilizer Test With Cotton

The object of this test is to determine the differential response of spacing cotton at three degrees of soil fertility, or on poor, medium and fertile soils. These degrees of fertility are obtained by using unfertilized soil, and soil treated with 400 pounds and 800 pounds per acre of 4-8-4 fertilizer. Three spacings, single plants spaced at 12, 18 and 24 inches in 36-inch rows are used.

Over a four-year period, (1936-39) the 12-inch spacing produced significantly higher yields on all three types of soils than the 18 and 24-inch spacings. Except with the medium fertile soils, where there was a very slight difference in favor of the 24-inch spacing, the 18-inch spacing likewise produced a higher yield than the 24-inch spacing.

Green Manure Test

The object of this test is to determine the amount of nitrogen made available by vetch as a green manure crop for cotton. The test consists of 30 plats, half of which are planted with vetch and the other half left winter fallow. In the spring the hairy vetch is plowed under and all plats receive an application of commercial fertilizer, all nitrogen being withheld from those plats having vetch.

For the 3-year period, (1937-39) the average yield of the plats having vetch and an application of 500 pounds of 0-8-4 fertilizer was 280 pounds of lint cotton to the acre, as compared to 265 pounds for those plats having vetch and an application of 500 pounds of 4-8-4 fertilizer to the acre. This indicates that vetch adds more nitrogen to the soil than cotton can use.

Variety Spinning Test

This test, conducted in cooperation with the United States Department of Agriculture, consists of two varieties, Stoneville 5 and Missdel 4, replicated twice. The object of the test is to determine the spinning qualities of these two varieties grown on Lufkin fine sandy loam soil. The results of this test are gathered by the U. S. D. A. at Stoneville, Mississippi, and have not been made public for either year 1938 or 1939.

Regional Variety Wilt Studies

This test, conducted on the station jointly by the Main Station Farm, the Division of Plant Pathology of the Texas Agricultural Experiment Station, and the U. S. D. A., has just been completed, covering a three-year period. A report of the results of the test will be found under the Division of Plant Pathology.

Corn Variety and Spacing Test

Through the generous cooperation of Mr. George Chance of Bryan, Texas, this test was conducted on the Chance Plantation in the Brazos River bottoms, representing a large area of heavy, fertile, alluvial soils, admirably suited to cotton production. Corn yields in the Brazos bottoms, however, are seldom comparable to yields obtained from cotton.

There were 100 varieties in this test, including the better known and more popular commercial varieties, some commercial hybrids, and many Texas Station top crosses. These varieties were replicated four times, twice at a spacing between plants of 15 inches and twice at a spacing between plants of 30 inches. Corn-belt hybrid seed producers recommend that hybrid corn be spaced closer than ordinary varieties, some even recommending only half as much space between plants as is usually allowed. These plantings at two different spacings were made to determine the effect of thick spacing.

The average yields of commercial varieties, Texas top crosses, and commercial hybrids were 26.6, 31.2, and 29.3 bushels per acre respectively. Although the commercial hybrids average slightly higher than the open-pollinated varieties, only one or two of the hybrids tested are significantly better than the highest yielding variety. Ear worm damage was 50.8, 47.6, and 64.7 per cent for the three groups. Almost all commercial hybrids, but particularly the Corn-Belt hybrids, were severely infested with weevils. Illinois hybrids in general were superior to Iowa hybrids but both were more productive than the other hybrids included in the test. No commercial hybrid included in this test is considered sufficiently productive and satisfactory in other respects to be recommended for general planting in this region.

Thick planting resulted in a loss of 4.0 and 8.3 per cent in commercial varieties and Texas top crosses respectively and a gain of 1.4 per cent in commercial hybrids.

Peanut Breeding

The Macspan x Virginia Bunch, a cross made in 1937 to get a peanut with the fine eating qualities of the Macspan and the non-sprouting quality of the Virginia Bunch when left in the field after maturity, was planted in the field this year. The plants were left in the field about six weeks after maturity was reached in order to give all the seed a chance to sprout. When the plants were finally harvested it was discovered that rodents had eaten or seriously damaged practically all of the seed that were not sprouted. If enough good seed can be salvaged from the lot, increased plantings will be made next year. If no seed of the cross are available it is planned to make the same cross at a later date.

Increase of Pure Seed

Increased plantings of Startex 619 cotton, Macspan peanuts, Yellow Surcropper corn, Surcropper Sugar sweet corn, Honey June sweet corn, and Red Shuck sweet corn were made in order to have seed available for distribution to seedsmen and farmers throughout the State and in other States.

J. E. Roberts.

PLANT PATHOLOGY AND PHYSIOLOGY

Cotton Root-Rot Investigations

(In cooperation with the Bureau of Plant Industry, U. S.
Department of Agriculture.)

Longevity of sclerotia. In October, 1929 (in cooperation with the late Dr. J. J. Taubenhaus), a large number of *Phymatotrichum omnivorum* sclerotia from a carrot field were placed in small vials of moist Houston soil and stored for periodic viability tests. Germination decreased grad-

ually to 12 per cent after 5 years, 10 per cent after 6 years, and 8 per cent after 7 years. None of the sclerotia from the last three vials, opened after 9, 9½, and 10 years, respectively, have germinated.

The Phymatotrichum spore stage. In continuation of studies on this spore stage of the root-rot fungus, germination tests were made of spores from intact spore mats chilled for periods respectively of 1 week, 8 months, and 15 months. As in earlier tests, no germination was obtained in these or in accompanying tests with fresh spores. Gradual increase of moisture and nutrient content of the soil did not induce development of spore mats in jars of soil containing extensive vegetative growth of the fungus.

Variation within the root-rot fungus. Variation and dissociation of *P. omnivorum* in pure culture have been noted earlier. To determine how rapidly such changes in the fungus may occur under field conditions, a root-rot-proof container was constructed in 1935 of sulphur slabs, and a pure culture of the fungus introduced by artificial inoculation of cotton plants grown in the container. Each year, cotton has been planted in this container, and reisolations have been made periodically from infected plants. Cultures reisolated in this way during 1939 have in preliminary comparison showed perfect agreement with the characteristics of the strain used in the original inoculation, as recorded at that time and as carried along in culture since then. A strain of the fungus kept in culture since August, 1929, retains the original characteristics of buff-colored strand growth and sclerotia production, and after 10 years in culture has been used in successful inoculation of cotton plants in the greenhouse and of cotton seedlings in tubes in the laboratory.

Nursery tests for resistance to root rot. Ratings on the relative susceptibility of more than 2,000 species of plants were published in Bulletin 527; however, there are many more species whose relationship to the disease is still to be determined. Tests on the susceptibility of additional plants have been conducted by growing the plants in a "root-rot nursery" where they are exposed to repeated artificial inoculation with the fungus and to contact with the disease from adjoining infected plants. Tentative new ratings include the silk-tree or mimosa tree (*Albizzia julibrissin*), apparently quite resistant (rating — or +); the bird-of-paradise flower or devil's moustache (*Poinciana gilliesii*), somewhat susceptible (++); and the linear-leaf Baccharis (*Baccharis neglecta*), rather susceptible (+++). Among plants being retested, the cutleaf chaste-tree (*Vitex negundo incisa*) and the ceniza or senisa (*Leucophyllum texanum*) appear somewhat more resistant than as previously listed.

Sulphur-slab containers for the exclusion of root rot. A container with sides and bottom of sulphur slabs, with powdered sulphur sprinkled in the joints where the slabs fitted loosely together, was constructed in the field in 1933, in cooperation with the late Dr. J. J. Taubenhause. Cotton planted around this container has been attacked year after year by root

rot, while plants growing inside the container have remained free of infection for 7 years.

Girdling and Topping of Cotton Plants as Affecting Survival of *Phymatotrichum omnivorum*

A further trial of girdling and topping (removing entire tops) of cotton plants was started June 30, 1939, in a field of Houston black clay soil near Brenham. The experiment included 18 small plots, all located at the advancing edges of root-rot spots. The roots were excavated 18 or 25 days later and the development of *P. omnivorum* in soil cultures observed.

The root-rot fungus was recovered, in this experiment, from 31.4 per cent of check plants, from 21.8 per cent of girdled plants, and from 9.5 per cent of topped plants. Including also the results of tests in 1938, percentages of plants from which the fungus was recovered were: check plants, 31.8; girdled plants, 21.3; and topped plants, 14.5. Both treatments not only reduced the number of plants on whose roots *P. omnivorum* survived for the short period of these tests, but also reduced the vigor of the fungus where it was still alive.

A longer trial of girdling of plants was furnished in an experiment started July 29, 1938 in an area with much root rot. In 1939, only 1 plant in the plot in which the 1938 plants had been girdled showed signs of root rot, and the disease did not spread from this plant, while root rot attacked plants occupying respectively 12 and 13 per cent of the area in the adjoining check plots. Much more extended field trial would be necessary to determine the practical usefulness of either girdling or topping of infected plants.

Age of Cotton Plants and Susceptibility to Field Inoculation with *Phymatotrichum* Root Rot

An experiment was set up at College Station during the summer of 1939, using 50 small plots arranged as 2 Latin squares. Cotton was planted on April 21, May 20, June 16, July 7, and July 28. The final planting was duplicated also between the rows of the oldest plants, so that this additional planting of youngest plants was exposed to infection from these old plants as well as from the inoculum. The entire field was inoculated with *Phymatotrichum* root rot on July 28. The final notes 3 months after inoculation showed agreement of age of cotton plants with susceptibility to root rot. With plants 14 weeks old at time of inoculation, 71.1 per cent succumbed to root rot; plants 10 weeks old, 60.4 per cent; plants 6 weeks old, 42.4 per cent; plants 3 weeks old, 16.6 per cent; and plantings made at the time of inoculation, 2.9 per cent for the regular series and 2 per cent for the series of young plants adjoining the oldest plants. Uninoculated check plots of the various plantings remained almost free of root rot.

W. N. Ezekiel.

Inoculation Experiments in the Greenhouse

Experiments undertaken in cooperation with the Division of Agronomy have been aimed at development of reliable methods for artificial inoculation of plants with *Phymatotrichum* root rot under greenhouse conditions. In preliminary trials, no infection of 13-day old cotton seedlings was obtained under conditions that allowed infection of older cotton plants transplanted from the field, of portions of cotton stems also taken from the field and rooted, and of rooted sweet potato cuttings. Naturally-infected cotton roots selected in the field have proved to be no better sources of inoculum than pure cultures of the fungus grown in flasks on sterilized cotton stems. Higher percentages of infection have been obtained with smaller masses of inoculum (35-50 gm.) rather than larger masses (100-125 gm.). With cotton plants growing in Houston clay, soil moisture contents of 20 per cent and 25 per cent, on an oven-dry soil weight basis, have been favorable for the development of root rot.

W. N. Ezekiel, H. E. Rea.

Studies on the Cause of Immunity of Monocotyledonous Plants to *Phymatotrichum* Root Rot

In cooperation with the Division of Chemistry, work has been continued on further separation and purification of the potent material from extracts of roots of monocotyledonous plants. This work is directed toward the identification of the ether-soluble, acidic material, apparently of general occurrence in roots of monocots, that prevents growth of the root-rot fungus.

W. N. Ezekiel, S. H. Wender.

Field Studies on Cotton Root Rot

The testing of *Gossypium* species for resistance to root rot was continued in 1939. The material tested during the period 1937-1939 included *Gossypium thurberia*, *G. harknessii*, *G. purpurescens* (2 collections), *G. barbadense* (5 collections), *G. braziliense* (2 collections), *G. peruvianum*, *G. arboreum*, *G. nanking-soudanensis*, *G. nanking-indicum*, *G. indicum*, *G. neglectum* (2 collections), *G. sanguineum*, *G. transvaalense*, *G. hirsutum* x *tomentosum* (2 collections), *G. hopii*, *G. intermedium*, *G. obtusifolium*, *G. patens*, *G. religiosum* (10 collections), fourteen collections of *G. hirsutum* from foreign cotton breeders, genetic stocks of *G. hirsutum* which carried factors for green lint, brown lint, lintlessness, red leaf, virescent yellow leaf, okra leaf, cream pollen, light yellow pollen, or dark yellow pollen in various combinations, and progenies of individual surviving plants in a severely root-rot damaged field of a commercial variety of *G. hirsutum*. No evidence of resistance was found.

Greenhouse Studies on Infection of Cotton Seedlings

Cotton seedlings, 21, 28, and 36 days after planting in Houston clay, were inoculated by introduction of sclerotia into the soil near the seedling

roots. With soil temperatures at 26-28° C. and with soil moistures at approximately 36 and 45 per cent of the maximum water-holding capacity, above ground symptoms of disease were evident in certain of the seedlings within ten days, regardless of the age of the seedling. The lowest soil moisture (27 per cent) was unfavorable both for the growth of the seedling and for infection. Only 3 per cent disease was observed after 24 days exposure to infection. Statistical analysis of the results showed that the two highest soil moisture groups did not differ significantly in the amount of disease, but both differed significantly from the lowest moisture. A significantly greater amount of disease was present in the oldest group of plants (36 days at time of inoculation) than in either of the younger groups. The rate of development of disease was more rapid in the older plants than in the younger ones.

In a subsequent experiment, with soil moisture at 36 and 45 per cent and with inoculation 10 days after planting of the seed, approximately 35 per cent of the seedlings had collapsed within 18 days.

L. M. Blank (Bu. Pl. Ind.)

Growth Response of *Phymatotrichum omnivorum* to Certain Inorganic Nitrogen Compounds

The mean weights of fungal mats produced on a standard nutrient solution with equivalent amounts of nitrogen derived from NH_4NO_3 , KNO_3 , $\text{Mg}(\text{NO}_3)_2$, $\text{KNO}_3 + \text{Mg}(\text{NO}_3)_2$, or $\text{Ca}(\text{NO}_3)_2$ are greater than those obtained with nitrogen from $(\text{NH}_4)_2\text{HPO}_4$, NH_4Cl , $(\text{NH}_4)_2\text{SO}_4$, $(\text{NH}_4)_2\text{HPO}_4 + \text{NH}_4\text{Cl}$, $(\text{NH}_4)_2\text{HPO}_4 + (\text{NH}_4)_2\text{SO}_4$, $(\text{NH}_4)_2\text{HPO}_4 + \text{NH}_4\text{Cl} + (\text{NH}_4)_2\text{SO}_4$, or $\text{NH}_4\text{Cl} + (\text{NH}_4)_2\text{SO}_4$. Of the ammoniacal sources of nitrogen, $(\text{NH}_4)_2\text{HPO}_4$, or combinations in which it is present, consistently yielded heavier mats than did NH_4Cl , $(\text{NH}_4)_2\text{SO}_4$, or combinations of the two. Determinations of the pH values of the solutions at time of inoculation and at time of harvest suggest that the rapid shift from approximate neutrality to a strongly acidic condition is responsible for the poor growth with the ammoniacal sources of nitrogen. The addition of CaCO_3 or Na_2CO_3 to the solutions with the above nitrogen sources had little or no beneficial effect upon the amount of growth in the solutions with nitrate nitrogen but generally increased the growth in solutions with ammoniacal nitrogen. MgCO_3 exhibited a depressing effect upon growth with NH_4Cl , $(\text{NH}_4)_2\text{SO}_4$, or $\text{Mg}(\text{NO}_3)_2$; it increased the amount of growth with the other NH_4 sources; and it usually had little effect upon the amount of growth with the other NO_3 sources. In order to obtain additional information on the effect of pH, experiments employing buffered solutions have been conducted.

With nitrogen derived from NH_4NO_3 , $(\text{NH}_4)_2\text{HPO}_4$, or $(\text{NH}_4)_2\text{SO}_4$ it has been demonstrated that the nitrogen concentration used in these experiments was well below the upper limits of tolerance for growth. Over a range of concentrations of nitrogen (equivalent to .00625 to .0750 M. NH_4NO_3), CaCO_3 at .0125 M. was effective in increasing fungal growth

with $(\text{NH}_4)_2\text{HPO}_4$ and $(\text{NH}_4)_2\text{SO}_4$ but had little or no effect upon solutions containing NH_4NO_3 . In experiments with nitrogen derived from NH_4NO_3 , NH_4NO_2 , and KNO_3 the yields were in the approximate ratio of 10:5:3, respectively.

L. M. Blank (Bu. Pl. Ind.), P. J. Talley.

Chemical Investigation of Resistance of Plants to *Phymatotrichum* Root Rot

To obtain a clearer conception of the nature of resistance in plants, the isolation of compounds from plants resistant or immune to *Phymatotrichum omnivorum* and the study of their influence on the growth of the root-rot fungus under controlled conditions has been continued. In order to classify compounds inhibitory to the root-rot fungus the roots of a number of plants were successively extracted with a series of six solvents. Of the resistant or immune plants, potent extracts were obtained from pokeberry (*Phytolacca americana*), sour orange (*Citrus aurantium*), hardy orange (*Poncirus trifolata*), coralberry (*Symphoricarpos orbiculata*), cowpea (*Vigna sinensis*, resistant strain), Johnson grass (*Sorghum halepense*), couch grass (*Agropyron repens*), and retama (*Parkinsonia aculeata*), while nothing inhibitory was found in Turk's-cap (*Malvaviscus conzattii*) and spiny amaranth (*Amaranthus spinosus*) which are classified as resistant nor in cotton (*Gossypium hirsutum*) and china-berry tree (*Melia azedarach*), which are susceptible.

Attempts to distinguish between cotton grown on nitrogen fertilized plots and that from check plots by the above extraction process were inconclusive. It has been found that betaine, a nitrogen base found in cotton roots, is inhibitory to the root-rot fungus and a method for its estimation in root tissue has been tentatively adopted.

Two substances inhibitory to growth of the root-rot fungus have been isolated from the root bark of sour orange. The first is an alkaloid (melting point of HCl, 196°) which, although preventing growth of the fungus at 100 parts per million, was found only in minute amounts. The second is an unsaturated lactone ($\text{C}_{18}\text{H}_{14}\text{O}_4$) which is present at a concentration of 0.8 to 0.9 per cent and prevents growth at 50 parts per million. Occurring with the lactone and an aromatic oil is a yellow phenolic compound ($\text{C}_{18}\text{H}_{17}\text{O}_5$), melting at 246°C ., which is not inhibitory.

A manuscript on the toxicity of 45 phenols and related compounds has been approved for publication. In another experiment completed, the effects of 62 alkaloids on the growth of *P. omnivorum* and of 6 alkaloids on the growth of *Sclerotium rolfsii*, *Fusarium vasinfectum*, *Verticillium albo-atrum*, *Rhizoctonia solani*, *Armillaria mellea*, and *Ophiobolus graminis* have been studied. In general the relative toxicity of the alkaloids studied on the growth of the root-rot fungus follow the relative resistant rating of the plant from which they were isolated. A study of the fungistatic effects of a series of fatty acids shows that the saturated members of

the series increase in toxicity until the chain contains 11 carbon atoms (no growth at 15 parts per million with undecylic acid) but that those containing 12 or more carbon atoms are not at all inhibitory. The work with alkaloids, phenols, glucosides, and fatty acids is of particular interest to the problem since these types of compounds are widely distributed in nature and many are inhibitory to the root-rot fungus. A similar evaluation of a number of quinoline compounds is being conducted on account of their relationship to the alkaloids. Of all the compounds we have tested so far against *P. omnivorum*, 8-hydroxyquinoline is the most potent, preventing growth at 0.5 parts per million.

On the hypothesis that phenols might be present in Johnson grass, the fresh roots and rhizomes of this species were extracted with boiling alcohol, and found to contain p-hydroxybenzaldehyde (0.3-5 per cent, dry wt. basis), and palmitic acid (0.1 per cent). Palmitic acid is not inhibitory, and p-hydroxybenzaldehyde, though it prevents growth at 0.05 per cent, was shown to have arisen from hydrolysis of a glucoside (presumably dhurrin) during the extraction. Amygdalin, a glucoside similar to dhurrin, has been found, in the presence of glucose, to stimulate growth of *P. omnivorum* slightly. Dhurrin is being isolated in quantity from the plant to aid in determining the possible role of the glucoside and its hydrolytic products in the resistance of Johnson grass.

From the underground parts of *Canna indica* was isolated an acid which is apparently a member of the higher aliphatic series (resembling cerotic acid) and which is non-toxic to the fungus. A mixture of phenols was also obtained which were precipitated by bromine water but was too complex to give a sharp melting point. This material prevents growth at about .05 per cent and is being subjected to fractional extraction to separate the various components.

Further studies have been made of the berberine content of Mahonia species and of prickly ash (*Zanthoxylum americanum*). A technique for the germination of the seeds of agarita (*M. trifoliolata*) was worked out. The roots of two-month-old plants were found to yield 0.29 per cent berberine. The root bark from two species of barberry (*Mahonia Bealii* and *M. aquifolium*) and from prickly ash were examined for the percentage of berberine; the yields were 2.01 per cent, 0.77 per cent, and 0.29 per cent, respectively. Berbamine (.01 per cent) has been found in Texas mahonia (*M. Swaseyi*) root bark tissue.

The occurrence and localization of alkaloids in the native Amaryllidaceae were studied. The zephyr-lily (*Zephyranthes texana*) and prairie lily (*Cooperia pedunculata*) have yielded a crystalline alkaloid (approximate conc. .08 per cent) $C_{16}H_{17}O_4N$, melting point $277^{\circ} C.$, identified as lycorine. This alkaloid prevents growth of *P. omnivorum* at a concentration of 30 parts per million. Preliminary experiments on the localization of the alkaloid indicate that it is mainly in the surface tissues of the bulb. The

roots contained the alkaloid in the epidermis, parenchyma, raphide, and endodermis cells.

G. A. Greathouse (Bu. Pl. Ind.), N. E. Rigler.

Cotton Root Rot Investigations at Temple and Iowa Park

Further experiments on the control of cotton root rot and results of cotton seed treatments are included in the reports of Substation No. 5, Temple, and Substation No. 16, Iowa Park.

Regional Cotton Wilt Studies

A 3-year test of wilt resistance of cotton varieties, to determine the relative susceptibility of certain varieties of cotton to wilt (*Fusarium vasinfectum*) and the effects of additions of potash fertilizers on the degree of resistance, conducted in cooperation with the Division of Cotton and Other Fiber Crops and Diseases, B. P. I., was completed in 1939. During the 3-year period, there was little wilt at College Station. Certain varieties were apparently more susceptible to the disease: Half and Half, Coker 100, D. & P. L. 11a and 12, Dixie Triumph 14-5 St. 2, and Cook 144-68. Relatively less susceptible varieties included Rowden 2088, Cook 307, Coker's 4 in 1, Dixie Triumph 85, Miller 610, Cleve wilt 6 and 7, Toole, Sikes W. R. Staple, and Dixie Triumph 12.

G. E. Altstatt, D. T. Killough, J. E. Roberts.

Similar studies at Jacksonville are described under Substation No. 11, Nacogdoches.

Fruiting of Cotton

A new project has been undertaken to study the fruiting process in cotton, especially as regards the water relations of the plant. One purpose of the study is to devise means for preventing the excessive shedding of squares and immature bolls which takes place under certain conditions. A greenhouse has been constructed for this work.

Counts made on 270 non-treated plants in the field showed that the plants formed (on an average) 38 squares and that 18 per cent of these remained on the plant to form mature bolls (6.8 bolls per plant). A few treatments (including irrigation, puncturing of bolls and squares, girdling of stems, oil spray, and removal of leaves or squares) applied to 145 plants, scattered among the non-treated plants, gave small increases, in some cases, in the percentage of squares reaching maturity.

In the greenhouse, plants grown in sand culture from August to December formed, on an average, 20.5 squares per plant and 27 per cent of these were retained until the bolls (5.5 per plant) were full-grown. Cotton plants grown in small containers, although occasionally subjected to severe drought conditions, produced nearly the same numbers of

squares and mature bolls as did plants of greater size that were grown in larger containers with a more constant supply of water. Maximum shedding of the bolls took place at definite periods regardless of the age of the plant. One spray application of a 10 p.p.m. solution of naphthyl acetamide (a compound reported to have prevented dropping of apples) had no apparent effect on boll shedding.

A. A. Dunlap.

Tomato Diseases

Plant Injury Resulting from Soil Drenches. Experiments on the drenching of soil in cold frames following the setting of young plants indicated that Basicop (2 lbs. to 50 gal.), malachite green ($\frac{1}{4}$ lb. to 50 gal.), Copper Hydro "40" (4 lbs. to 50 gal.), Cuproside 54 ($1\frac{1}{4}$ lbs. to 50 gal.), and ZO ($1\frac{1}{2}$ lbs. to 50 gal.) had little or no immediate effect on plant survival or later on plant size. Bordeaux 3-3-50 and U. S. Fungicide 20 ($1\frac{1}{2}$ lbs. to 50 gal.) caused severe injury. Only traces of damping-off and collar rot were present in the experiments.

Spraying tomatoes. Three applications of a number of sprays were applied on tomatoes in two separate experiments. No foliage diseases were present. All treatments caused some reduction in the number and weight of fruits produced in one experiment, while in the other the results were very variable due to occurrence of tomato wilt. The sprays that caused only slight injury were Cuproside 54 ($1\frac{1}{4}$ lbs. to 50 gal.), Cuproside 54 Y (1 lb. to 50 gal. and 2 lbs. to 50 gal.), General Chemical potato spray (4 lbs. to 50 gal.), malachite green ($\frac{1}{4}$ lb. to 50 gal.), ZO ($\frac{3}{4}$ lb. to 50 gal.), U. S. Fungicide 20 ($\frac{3}{4}$ lb. to 50 gal.), Sherwin Williams 75K (4 lbs. to 50 gal.), and Kopper King (2 lbs. to 50 gal.). Bordeaux mixture 4-4-50 caused a marked reduction in the number and weight of fruits produced. The addition of cotton seed oil or sulphur did not materially affect the results with Bordeaux mixture.

Factors affecting the inoculation of tomatoes with *Fusarium lycopersici*. A method of testing tomatoes for resistance to *Fusarium* wilt has been used extensively this past season on a large number of varieties and has given results comparable to those obtained under field conditions. The method consists of dipping the roots of young plants in 3 to 8-day-old liquid nutrient cultures of *F. lycopersici* and then setting the plants in trays or cold frames. Symptoms of tomato wilt usually appear in from ten to fourteen days if moisture and temperature conditions are favorable.

Young Marglobe tomato plants were inoculated under various conditions during August, September, and October in the greenhouse at College Station. The period of immersion of the roots in the inoculum, from an instant dip to a soak of 16 minutes, had no significant effect on the results. Cultures incubated from three to eight days at room temperature were found to be more virulent than older cultures. Removal of the mycelium, by filtering the culture through cheesecloth, only slightly reduced the virulence of the inoculum. Plants dipped in 8-day-old cultures that had

been autoclaved for 30 minutes at 15 pounds pressure, in uninoculated nutrient broth, or in water, remained healthy. Wilt developed on inoculated plants set in Lufkin fine sandy loam that had been adjusted to reactions ranging from pH 9.3 to pH 3.5. It was progressively more severe from pH 7 to pH 3.5. The smallest amount of wilt developed at pH 9.3. Inoculated and check plants died when set into soil adjusted to pH 2.9. Tomato wilt was more severe on inoculated plants set in wet Lufkin fine sandy loam soil than when set in dry soil. The wilt on plants set in the moist soil was intermediate in severity. The moisture content of these soils based on the water-holding capacity was 56, 29, and 14 per cent. Different isolates of *F. lycopersici* varied as to pathogenicity.

Varietal resistance of tomatoes to Fusarium wilt. Over 250 varieties, strains, and selections of tomatoes were tested for resistance to wilt under field and laboratory conditions. Varietal resistance was compared from the indices of infection obtained from counts made of the number of plants dead, severely affected, slightly affected, and healthy at ten to fourteen-day intervals during the growing season. A final weighted index was calculated for each variety, taking into account both the time and severity of infection. In the laboratory tests, only three classes were used and the interval between counts was determined by the season and the temperature. Some South American tomatoes had more resistance to tomato wilt than any commercial variety tested. Many of the so-called wilt resistant tomatoes were found to be too susceptible to tomato wilt to be of commercial value in this area. The varieties most resistant and the best adapted to the Yoakum-Hallettsville area are Marglobe, Rutgers, Glovel, Grothen's Globe, and Pritchard.

A. L. Harrison.

The perfect stage of *Sclerotium rolfsii* Sacc. During the course of cultural studies of different strains of *S. rolfsii*, a fungus causing large annual losses of tomatoes and other crop plants in the Southern States, what appears to be the perfect stage has been produced. This stage has been recorded in Japan, Italy, India, and once from California. In our experiments strains of *S. rolfsii* from watermelon, peanut, sugar beet, and garlic produced the perfect stage.

The fruiting structure is a hymenium bearing basidia, sterigmata, and spores. A few of the spores have been measured, their sizes ranging from 3.9 to 5.4 μ in length by 1.8 to 3.6 μ in width. Both the perfect stage and the sclerotial stage are found in the same cultures.

Transfers from portions of the mycelium and hymenium have produced colonies typical of *S. rolfsii*. Sclerotia from fruiting cultures have also produced new colonies with typical sclerotia. Portions of the hymenium fastened to the underside of the Petri dish cover discharged spores on the

sterile agar surface below, which germinated and produced colonies having mycelium and sclerotia typical of *S. rolfsii*.

G. E. Altstatt.

Tomato disease investigations at Jacksonville. The work of the Tomato Disease Laboratory at Jacksonville is included in the report of Substation No. 11, Nacogdoches.

Diseases of Garlic and Other Vegetable Crops

Selection and disinfection of garlic cloves for planting. Garlic clove selection and disinfection gave definite increases in yield in 1939. Untreated small cloves from U. S. No. 1 garlic produced an acre yield of 765 pounds as compared to 1,057 pounds from untreated large cloves and 1,443 pounds from untreated cloves from especially selected nearly disease-free bulbs. Untreated selected, large cloves from U. S. No. 2 grade garlic yielded 815 pounds per acre. Clove disinfection helped to obtain a good stand. The acre yield of cured, dry garlic (based on 3-foot row width) from selected untreated cloves was 1,159 pounds, as compared with cloves treated with Semesan 1,376 pounds, malachite green 1,226, Ceresan 1,162, sulphur 1,152, mercuric chloride 1,113, formaldehyde 1,086, Cuprocide 943, and Cuprocide "54" 856 pounds.

Spacing rows for garlic. At College Station, in rows spaced 12 inches apart, the calculated yield per acre was 4,092 pounds of salable garlic. (The average acre yield for Texas is estimated for 1939 at 1,700 pounds). In this plot, however, hand cultivation was necessary and it was irrigated 3 times during the latter part of the season.

Harvesting and curing studies. The effects of various harvesting, drying, and storage methods upon the amount of bulb decay are reported under the Division of Agricultural Engineering.

G. E. Altstatt, H. P. Smith.

Vegetable disease work at Winter Haven. Results of experiments with downy mildew of cantaloupes, eggplant yellows, tomato fruit pox, downy mildew of spinach and pink root of onions are given under Substation No. 19, Winter Haven.

S. S. Ivanoff.

Vegetable disease work in the Lower Rio Grande Valley. Studies on scab and early blight of potatoes, early blight of tomatoes, and black rot of cabbage are reported under Substation No. 15, Weslaco.

G. H. Godfrey, H. Rich.

Diseases of Other Crops

Control of crapemyrtle mildew. Three applications during April and May of 325-mesh dusting sulphur or of 325-mesh dusting sulphur (90

parts) plus Cuprocide GA (10 parts) gave almost complete control of crapemyrtle mildew. Cuprocide 54 Y (2 lbs. to 50 gal.) plus cotton seed oil and Lethane spreader gave partial control.

A. L. Harrison.

Rose disease work at Tyler. Experiments on the control of blackspot, die-back, mildew, and crown gall of rose are included in the report of Substation No. 2, Tyler.

E. W. Lyle.

Investigation of rice diseases. Studies of black kernel, white tip, and straight head of rice are reported under Substation No. 4, Beaumont.

A. L. Martin, C. E. Minarik.

Citrus diseases and chlorosis of ornamentals. The results of studies on citrus stem-end rot and the use of sulphur composts for control of chlorosis are given under Substation No. 15, Weslaco.

G. H. Godfrey, H. Rich.

SOIL SURVEY

(In cooperation with the Bureau of Plant Industry,
U. S. Department of Agriculture)

Soil survey work was carried on in four counties during 1939. These were Brown, Cherokee, McLennan, and Uvalde Counties, and the total area surveyed in detail amounted to about 500,000 acres. The surveys were made by State and Federal men. The work was continued along the same lines as in the past, and the national system of soil surveys and soil classifications used requires the same standards and correlations as those employed in all other states. The soil maps and reports of counties are increasingly in demand by agencies concerned with studies of various agricultural problems and by farmers and landowners generally. The data of these surveys are used largely by specialists and organizations concerned with land use planning. Refinements in soil classification data make larger scale maps necessary in order to meet the needs of the various organizations using the data. The land must be mapped in greater detail, therefore, and it has not been possible to make as much progress in the surveys as formerly.

Soil Survey of Brown County

The soil survey of Brown County was completed during the year, and the report and field sheets were forwarded to the Bureau of Plant Industry in Washington where the data are being prepared for publication by the U. S. Government Printing Office.

The soil survey of this county provides information on the soils which will be of value in using lands included in the irrigation project developed near Brownwood. Although the county lies in a region where dry farming

is successfully carried on, during some seasons irrigation will provide an additional amount of moisture needed to insure good yields of many of the farm and special crops to which the soils are suited. The county comprises a transitional area where the humid and subhumid climatic regions merge, and in some seasons, therefore, rainfall is irregular and deficient. It also lies where three important soil regions meet—the Grand Prairie, the Rolling Plains, and the West Cross Timbers. The varied climatic and soil parent material formations have influenced the development of many different kinds of soils within small areas.

More than 60 different kinds of soils, including soil types, soil phases, soil complexes, and land types, were mapped. Five general groups of soils based on general features of character and land use suitabilities are in the county.

The most extensive general farming group comprises large and small bodies of land, totaling about 190,000 acres, of dark heavy soils of the uplands of the Abilene, Denton, and related soil series. They are rather deep and productive and suited to small grains, cotton, corn, sorghums, and other feed crops.

The sandy soils, which support, where uncleared, a timber growth mainly of oak trees, occur in many small areas and total about 103,000 acres of upland. They are well suited to vegetables, fruits, berries, peanuts, and some of the general farm crops, such as cotton, corn, sorghums, and other feed crops, but are generally of lower productive capacity than the heavy dark soils. The soils of this group usually require added fertility for best production. As they are in many places subject to severe wind and water erosion, they require careful management to prevent deterioration. These soils are largely of the Windthorst, Stephenville, and Nimrod series.

The smooth valley soils occur in narrow strips along the creeks and rivers and generally are the most productive soils in the county. They include about 60,000 acres and are largely of the Frio, Yahola, and Spur series.

About 40,000 acres of various thin soils of miscellaneous character are scattered over the county. These soils, although arable, are not sufficiently productive to be used for cultivated crops. Some are cultivated, but they are better suited for pasture land, as some grasses grow better on them than farm crops.

Many small and large bodies of rough or stony or very thin lands occur. These are unsuited for cultivation and comprise highly desirable range lands for livestock consisting of cattle, sheep, and goats. The areas amount to about 220,000 acres.

E. H. Templin, I. C. Mowery, W. T. Carter.

Soil Survey of Cherokee County

Early in the year the soil survey of Cherokee County was started. This is an important farming area of sandy soils lying within the soil

region known as the East Texas Timber Country. Agriculturally, the county has become increasingly important, due to the large amount of truck crops produced and shipped to various markets of the country. Although general crops such as cotton, corn, and other feed crops are still grown largely, the production of special crops such as tomatoes, peanuts, sweet potatoes, and other truck crops and fruits is receiving much attention. It is expected that the soil survey will provide a basis for the use of soils for crops to which they are best suited and information concerning the correct use of fertilizers, enabling proper practices for preserving the soils and the soil fertility. The information of the soil survey will be useful to the specialists of the Experiment Station who are engaged in research work in the county dealing with various agricultural problems such as crop diseases and parasites.

H. M. Smith, J. W. Huckabee, Jr., I. C. Mowery, W. T. Carter.

Soil Survey of McLennan County

A soil survey was started in McLennan County during the year. The Soil Conservation Service will also cooperate in making this survey, as that agency has already covered the part of the county lying in the area included in the soil conservation survey of the Lake Waco watershed.

McLennan County has an area of about 671,000 acres and is an important agricultural county of east-central Texas. The eastern part is occupied largely by the Blackland Prairie and the Brazos River valley and the western part by the Grand Prairie. A very large proportion of the land area is in cultivation. The crops are chiefly cotton, small grains, sorghums, corn, and various other feed crops, including some alfalfa on the bottom-land soils.

The survey is being made at the request and by petition of a number of citizens of the county, including farmers, other landowners, and business men, in order to provide information for use in indicating suitable soils for particular crops and in planning practices for the conservation and improvement of the soils and maintaining and increasing their fertility.

E. H. Templin, A. L. Nabors, W. T. Carter.

Soil Survey of Uvalde County

At the request of the citizens of Uvalde County a soil survey was started there early in 1938. Due to the employment of the State soil surveyors in other areas at the time, the Bureau of Plant Industry surveyor worked alone until withdrawn in May for work in another state. Only a very small part of the county, therefore, has been surveyed, but work in the county will be resumed early in 1940.

Uvalde County is in the southwestern part of the State about 50 miles east of the Texas-Mexico boundary. It lies at the extreme western limit of the systematic dry farming area, although some dry farming is done

in the eastern half of the county. A very large part of the county is still used for the grazing and browsing of range livestock consisting of cattle, sheep, and goats. A very large proportion—the northern and western parts—is occupied chiefly by rough and stony lands of the Edwards Plateau where only in some narrow valleys is cultivation possible. The southern part of the county lies in the Rio Grande Plain where large bodies of smooth deep soils occur. The valleys and some of the smooth upland areas are favorably situated for the use of irrigation water, and possibly sources of water will be developed from reservoirs and wells permitting extensive irrigation in various parts of the county.

The soil survey is expected to provide information that will be of use in utilizing the soils to the best advantage, either for dry or irrigation farming and for the production of range livestock.

W. I. Watkins, W. T. Carter.

Land Use Planning

During the year considerable work has been done in providing generalized soil maps and reports for the use of county committees and specialists of the Experiment Station division of Farm and Ranch Economics and the Extension Service who are working with county committees in devising plans for correct land use on a county basis. Young and Parker Counties were surveyed in reconnaissance, as these counties had never had soil surveys, and generalized soil maps on the scale of one inch to the mile with brief reports were turned over to the committees and specialists as a basis for preparing plans for these counties.

As the requests for the work in preparing soil and land use maps for county land use planning have become more numerous, one man has been transferred from the soil survey field work to this office and, working by cooperative agreement with the Bureau of Agricultural Economics, is to give his entire time to preparing general soil and land group maps and reports for the various counties in which this planning work is being done. The maps are made on a county road map prepared by the State Highway Commission, and the land areas indicated consist of groups of soils similar in characteristics and use capabilities. Thus far, three additional county maps have been prepared for the committees. These are Bowie, Houston, and Victoria Counties. These counties have been covered by detailed soil surveys, some of which were made many years ago, and the detailed soil areas are grouped on the general soil map and descriptions written to conform to the requirements of the land use specialists and committees in these counties.

J. W. Huckabee, Jr., E. H. Templin, W. T. Carter.

FARM AND RANCH ECONOMICS

Organization and Management of Farms in the High Plains Cotton Area of Texas

(In cooperation with the Bureau of Agricultural Economics, U. S. D. A.)

A detailed study of organization and management has been made on farms in the High Plains Cotton Area during the five-year period 1931-1935. The main objective of the study is to furnish basic farm management data that will be useful to farmers and farm leaders of the area in understanding and solving the farm problems confronting them.

Bulletin No. 568, "An Economic Study of Farm Organization and Operation in the High Plains Cotton Area of Texas," has been published. Another publication, entitled "Planning for Adjustments in Farming in the High Plains Cotton Area of Texas," is almost completed. This bulletin will deal primarily with the practices used in the production of various crops and classes of livestock, with methods of soil and moisture conservation, and with the effect of these various practices on production. An important phase of the bulletin is the evaluation of alternative systems of farming under varying price relationships. A third publication, in process of preparation, entitled "Farm Credit in the High Plains Cotton Area of Texas," will deal with the use of credit on farms in the area.

C. A. Bonnen and A. C. Magee; and B. H. Thibodeaux,
Bureau of Agricultural Economics.

Regional Agricultural Adjustment

(In cooperation with the Bureau of Agricultural Economics, U. S. D. A.)

The purpose of this project is to develop information, by type-of-farming areas, to facilitate the planning of agricultural adjustments in each area. The work is divided into two phases:

1. The descriptive phase in which the State has been divided into areas that have a high degree of similarity in soils and other physical features, as well as in the character of the agriculture and its related physical and economic problems. A general treatment of this phase was published in Bulletin No. 544, "A Description of the Agriculture and Type-of-Farming Areas in Texas," in 1937.

Further refinement of this material is the present objective of this project. The leaders of the project are cooperating with the Extension Service in the work of agricultural land use planning. This entails dividing each county into areas in much the same manner as the State was divided into major type-of-farming areas. Each area identified within a county is then described as to its soils, topography, native vegetation, and present land use. During the past year, Agricultural Adjustment Administration data have been analyzed to determine present land use and crop land

organization for farms in counties designated for intensive work. Live-stock surveys were also made to indicate the livestock organization of these farms. Mimeographed reports were prepared for twelve counties in which work of this type was done.

2. The analytical phase, in which is developed detailed information pertaining to the production and production requirements of the alternative uses of land. This will permit an appraisal of present systems of farming and of land use changes which may be proposed from time to time.

Work already under way in the Rolling Plains, the Black Prairie Area, and the High Plains Wheat Area was continued. Data have been summarized in the last two areas named.

Field work has been completed and data summarized in the first area named. A manuscript, entitled "Planning for Adjustments in Farming in the Rolling Plains Area of Texas," will be ready for publication sometime during the coming year. This publication, while describing the agriculture and agricultural resources of the area, deals primarily with the relation of farm organization and operation to soil type and with variations in farm earnings due to differences in systems of farming. The most important factor causing variations in farm earnings in 1935 were soils, crop yields, size of farm, and the cropping system followed.

Average farm earnings in 1935, measured as labor and management wage, were 1,009 on heavy dark upland soils, and \$731 and \$647 on heavy reddish upland and sandy upland soils, respectively. Bottom land farms returned \$526. Farm income tended to increase as crop yields increased. For example, on farms having heavy dark upland soils, those with crop yield indexes of less than 95, 95-119, and 120 and over returned a labor and management wage of \$684, \$1,131, and \$1,397, respectively. Similarly, when these same farms were grouped on the basis of size, the average labor and management wage was found to be \$713, \$1,061, \$1,147, and \$1,299, respectively, for farms of 120 acres or less, 121 to 180 acres, 181 to 260 acres, and 261 acres and over in size. In 1935, farms with less than 40 per cent of the crop land in cotton returned \$841, while those having from 40 to 49 and from 50 to 74 per cent in cotton earned \$1,118 and \$1,159, respectively.

Work on the analytical phase of this project was initiated in the North-Central Grazing Area during the year. This work is being carried on in connection with the unified land use planning program being conducted in Young County. Field work has been completed and the data summarized. A report on this material will be prepared during the coming year.

During the past year, a study was made in the High Plains Wheat Area to determine the accomplishments of the Agricultural Adjustment Administration programs in promoting the long-time objectives of soil conservation and economic use of land resources. Field work for this

study has been completed, the data have been summarized, and a report has been prepared.

C. A. Bonnen and A. C. Magee; and B. H. Thibodeaux,
Bureau of Agricultural Economics.

Operating Costs and Financial Conditions of Gins in Texas

During the year, 200 cost records were added to those previously collected. As a means of increasing the uniformity of conditions under which gins operate, the State was divided into three areas designated as East Texas, West Texas, and South Texas. In terms of all records available, a cost analysis was made by type of power and section of the State. Total costs were correlated with the two variables, volume of ginning in running bales and investments in the gin plants. This procedure separates costs into three elements: (1) a residual item which includes that portion of the cost which is unrelated to volume and investment; (2) that portion of the cost which results from the investment in the gin plant; and (3) that portion of cost which results from the volume of ginning.

For steam plants of East Texas, the analysis yielded the following estimating equation:

$$\text{Estimated Cost} = \$1730 + \$0.0930I + \$1.78V$$

The item of \$1730 is the residual portion of the cost. This cost remains the same regardless of the investment or the volume of ginning. The item of \$0.0930I (I=Investment) shows the influence of investment. For every dollar added to the investment, total cost is increased by 9.3 cents. For a gin with an investment of \$10,000, the investment cost is \$930; for a gin with an investment of \$20,000, this cost is twice as great, or \$1860. The residual cost and the investment cost represent the fixed cost portion of total cost. The item of \$1.78V (V=Volume of ginning in running bales) shows the influence of volume of ginning. For every bale added to the volume, this cost is increased by \$1.78. This variable, or per bale, cost for 1000 bales is \$1780; for 2000 bales this cost is twice as great, or \$3560.

The application of this estimating equation may be shown for average conditions in East Texas. For the steam plants studied, the average investment was \$14,600 and the average volume of ginning was 861 bales. On the basis of 86 records, the average income per bale was \$5.54 (\$4.10 gin toll; \$0.39 and \$1.05 net profits on a per bale basis on bagging and ties and cottonseed). Thus under average conditions cost, gross income, and net income may be determined as follows:

COST		INCOME		
Fixed				
Investment	$\$0.0930 \times 14,600$	\$1358		
Residual		1730		
Total fixed		\$3088		
Variable	$\$1.78 \times 861$	1533		
Total cost		\$4621	$\$5.54 \times 861$	\$4770

The gross income \$4770 less the cost \$4621 gives a net profit of \$149. This makes an average return on capital invested of 1.0 per cent. It should be noted that these costs include manager's salary at \$859 per year and a cost of depreciation of \$968, which is not an out-of-pocket cost.

This low average volume of ginning is symptomatic of an over-expansion of ginning facilities in East Texas. If one gin out of every three were eliminated, then average volume would increase to 1292 bales. At this volume, the cost would be \$5388 and the income \$7158, leaving a net profit of \$1770. This would make an average return on capital invested of 12.1 per cent. If one-half the gins were eliminated, average volume would increase to 1722 bales. At this volume, net profits would be \$3387, yielding a return of 23.2 per cent on the invested capital. This relation between volume of ginning and net profit explains, in part, the success of cooperative gins. The cooperatives, as a rule, secure a considerably higher volume of ginning than the other types of gins.

The other estimating equations which were derived are:

East Texas

Diesel power.....Est. Cost = $\$2198 + \$0.0887I + \$1.37V$
 Electric power.....Est. Cost = $2089 + 0.0592I + 2.05V$

West Texas

Steam power.....Est. Cost = $\$3392 + \$0.0592I + \$2.25V$
 Diesel power.....Est. Cost = $1973 + 0.1120I + 1.76V$
 Electric power.....Est. Cost = $1528 + 0.1122I + 2.42V$

W. E. Paulson and L. P. Gabbard.

A Study of the Marketing of Turkeys in Texas

(In cooperation with the General Education Board)

This project was initiated during the year. The annual income to turkey growers in Texas is around ten million dollars. Texas is the leading state in point of production, but prices to growers seem to average about five cents a pound lower than to producers in the other leading producing states. One of the purposes of this study is to determine the reasons for this price discrimination.

In the main, the objects of the study are: to determine types and kinds of marketing agencies handling Texas turkeys; to ascertain present

practices relating to grading, processing, and packaging; to analyze the behavior of local prices; and to study the contributions of turkey co-operatives in solving marketing problems.

Arrangements were made with teachers of vocational agriculture to report on daily transactions in the local market during the Thanksgiving and Christmas marketing periods. These reports show the sex of the birds, the grade, the number of birds, the total weight, the price per pound, and the total receipts of the farmer making the sale. These reports were received from 38 local markets in the State. The transactions reported number more than 3000. These transactions will be analyzed at the earliest possible time.

W. E. Paulson and C. W. Carter.

Factors Affecting the Equitable Assessment of Rural and Urban Properties in Texas

(In cooperation with the Bureau of Agricultural Economics, U. S. D. A.)

During the latter part of the year, the Experiment Station, in cooperation with the Bureau of Agricultural Economics, U. S. Department of Agriculture, was requested by the County Land Use Planning Committee of Young County to make a survey of the tax situation in that county, giving special emphasis to equalizing taxes. The survey was begun late in the year. It has as its objective the development of basic data regarding the comparability of assessments for tax purposes as among properties in a given class and among the different groups of property, such as farm lands, urban residence, and commercial and industrial properties of all kinds.

Specifically, the survey is developing information regarding:

1. (a) The ratio of assessments to sales values.
(b) The ratio of assessments to appraised values of farmer committees.
2. Mapping tax delinquency by years and by areas.
3. Probate records for a period of ten years—classified as to real estate, chattels, and intangibles. Intangibles are to be broken down so as to determine the amount of such property exempt under state and federal laws.
4. Construction of a tax-load map showing taxes per acre by individual tracts.

Taxation relating to farm and ranch lands is taken up first, but the plan is to study all classes of property in a similar way. It is hoped that as a result of this and perhaps similar surveys in other counties a tax manual may be developed shortly which will be of practical value to local tax officials and others interested in the improvement of our tax procedure.

Progress was made in another phase of the farm tax project, namely, trend of taxes on farm and ranch lands in Texas. The tax index and

the tax ratio were completed for two additional years—1937 and 1938. This gives a series complete for the period 1913 to 1938, inclusive, and shows that the tax-price ratio has varied from 1.00 in 1913 to 4.88 in 1932. By 1938 it had fallen to 2.42.

L. P. Gabbard and H. C. Bradshaw.

Factors Affecting the Collection and Expenditure of Taxation Revenues in Texas

As stated in the Fifty-first Annual Report, this project is designed to study the administration of state and local taxes as they affect the farmer. In order to show the possibilities of reducing farm taxes through improved management of government in general, it is necessary to consider the administration of taxes in a very broad sense. Although the work of assessment and collection is of primary interest, it is also necessary to study such related activities as budgeting or financial management, accounting and auditing, and financial reports.

One of the important aspects of this project which has been studied is that of county budgeting. Through the courtesy of the Texas Highway Planning Survey, schedules have been secured on sixty counties distributed over the State. The total receipts of these counties amounted to approximately \$11,423,000 in 1935.

In examining the records of the sixty counties, each county fund has been considered as a separate unit. This examination reveals that the combined interest and sinking funds of each county had sufficient available resources (balances plus tax collections) to meet all payments in 1935. Of course, in addition to payments due in 1935, each county should have set aside the predetermined amount necessary to protect the retirement of term bonds. Whether or not this was done could not be determined from available records. However, it is believed that a relatively large percentage of the county bonds now mature serially and are not affected.

Exclusive of the interest and sinking, there were 231 funds in the sixty counties which might be classed as current or operating funds.

The expenditures of 83.1 per cent of these operating funds were kept within their available resources in 1935. The expenditures of the remainder, or 16.9 per cent of the funds, exceeded their available resources thereby incurring a deficit. Considered as a whole, this is an encouraging record. The expenditures of 90 per cent of the jury and permanent improvement funds were kept within their available resources. The corresponding percentages for the road and bridge and general funds were 80 and 73, respectively. In other words, the records made in the jury and permanent improvement funds were equally good. The record made in the road and bridge fund was considerably worse, and the general fund record was the poorest of all.

A preliminary analysis of these data indicates that the record made by the officials in keeping expenditures within available resources of each fund is directly related to the amount of revenue available, the level of expenditures, and the number of activities supported by each fund. Thus, the revenue available for the jury and permanent improvement funds is usually adequate, and the number of activities supported is small in number. On the other hand, while the road and bridge fund is limited entirely to road work, the level of expenditures is fairly high, and is subject to unpredictable increases due to floods and other emergencies. In terms of available revenue, the general fund is the hardest of all funds to keep on a cash basis. Not only is the level of expenditures high, but the general fund supports a large number of activities, and may be called upon to absorb emergency outlays of various kinds.

A bulletin, now in preparation, on the subject of county budgets should be completed during the coming year.

Attention has further been devoted to a study of the state government as it affects the fiscal affairs of local units. The analysis has sought to determine the number and cost of the state departments having some relation to local finance, the nature of these relations, and the organization and functioning of each such department.

During the past year, a study of the county unit system of road and bridge work in Harrison County, Texas, was completed. This study was mimeographed and released as Progress Report No. 608.

H. C. Bradshaw and L. P. Gabbard.

The Economic Significance of Different Farm Leasing Systems in Texas

This project is designed to study the characteristics of the various systems of leasing land in Texas and to provide factual data as an aid in improving leasing agreements. Particular attention has been devoted to the influence of mechanization upon the tenancy situation, to the development of effective livestock share leases, and to the distribution of farm income.

The effect which mechanization has had upon leasing arrangements is complicated by the presence of other factors. In areas adapted to tractor farming and where farms were previously small in size, however, a general increase in the size of farming units has occurred. This trend, in many instances, has been accompanied by the displacement of tenants. Since they represent variations in the economic and social pattern of agriculture in the State, both changes have influenced leasing arrangements. Likewise, as a result of the Government benefit program, rental rates have been modified, and the practice of charging cash rent for feed and pasture lands has increased. Livestock share leases, in conjunction with the crop-share system, are being used in many sections.

Because of the importance of livestock products as a part of the total farm products consumed at home, this development seems to offer an unusual opportunity for a better living on the farm for the tenant, and an increased income for the owner. Income records from selected farms in four major type-of-farming areas reveal the important contribution of livestock production to family living as well as to total income from the farming enterprise.

Based on a limited sample in four major type-of-farming areas, livestock products consumed at home account for 61 to 93 per cent of the non-cash farm income, while the cash and non-cash gain from livestock comprises from 19 to 29 per cent of the gain from all sources. Since, as a non-cash item, livestock has already approached the limit, it is evident that in the future the tendency will be toward production for cash.

In response to numerous requests for livestock leasing information, suggestions relating to the subject were incorporated into a report, titled "Livestock Share Leases on Cotton Farms," and made available to interested farmers. While no major publications covering the farm lease study have been issued, the following additional materials were released during 1939:

"An Experimental Farm Rental Agreement"—Progress Report No. 478 (Revised).

"The Social Effects of Recent Trends in Mechanization of Agriculture"—Progress Report No. 579.

"Statistics on Farm Tenancy for Texas"—Progress Report No. 580.

"Farm Population Changes in Texas During 1938"—Progress Report No. 644.

"A Survey of Public Opinion on Farm Ownership and Tenancy in Fourteen Representative Texas Counties."

C. H. Hamilton and L. P. Gabbard.

Additional Cooperative Projects

Farm Population Changes. In cooperation with the Division of Farm Population and Rural Welfare, Bureau of Agricultural Economics, U. S. Department of Agriculture, the Division surveyed and estimated the trend of farm population during 1938. A mimeographed report of this survey is available in the Division of Farm and Ranch Economics of this Station.

Social Correlatives of Land Tenure. This study was made in cooperation with the Farm Security Administration and the Division of Farm Population and Rural Welfare. Schedules were filled in Collin and Nacogdoches Counties and were used to augment the principal lease study.

A Study of Texas Farm Leasing Arrangements in Relation to the Conservation of Agricultural Resources with Special Reference to the

Formulation of Programs under the Soil Conservation and Domestic Allotment Act. The survey records used were coordinate with the schedules used in the principal study, but additional questions were included relating to the AAA program. The Bureau of Agricultural Economics and the Agricultural Adjustment Administration cooperated on this project. The same areas included in the Texas Lease Study were surveyed.

A Study of Renting and Cropping Arrangements. The Bureau of Agricultural Economics and the Agricultural Adjustment Administration were the cooperating agencies on this study, which covered 26 selected counties. Questions included in this survey were specifically related to contributions of expenses of landowners and their tenants under different types of leases and to rental rates on different crops and livestock enterprises. The data were collected in such a way as to show the contrasts between usual and unusual arrangements.

A Study to Delimit the Type of Tenancy Areas in Texas, and to Describe the Present Tenancy Situation in Each Area. This study is in cooperation with the Division of Land Economics, Bureau of Agricultural Economics. It evolves out of a long felt need for more exact information regarding variations in tenancy conditions in the different parts of the State, in order that future policies dealing with the problem may be adapted to the areas under consideration. Census data and mailed questionnaires will be used as a basis for delineating areas. A report on this project will be forthcoming before July 1, 1940.

C. H. Hamilton and L. P. Gabbard.

BOTANY

The identity and distribution of native vegetation is of considerable importance to the study of agricultural problems. Vegetation is an important item in furnishing feed for livestock. Some species of vegetation when eaten are harmful to livestock. Many species have value as honey producers. Plants also act as carriers of plant diseases and in this way have an important relation to agriculture.

The study of native vegetation in relation to livestock industry is centered around the work at the Ranch Experiment Station. It involves principally the occurrence of species which make up the range feed values and the occurrence of species which are harmful to livestock or have low range feed values. The study of the sequence of the different species also widens our knowledge of the extent to which these may affect range feed values.

The work in connection with honey plants is centered at the Apicultural Research Laboratory near San Antonio and is reported under the Division of Apiculture.

The study of vegetation as carriers of plant diseases is centered at Substation No. 5, Temple, primarily in connection with cotton root rot

disease work. Some additional work with plants as weed pests is being carried at the Winter Garden Station and at the Apicultural Research Laboratory.

SWINE HUSBANDRY

Relationship of Genetic Factors to Vitamin A Requirements in Mammals

(In cooperation with School of Agriculture, A. & M. College of Texas)

Two inbred and one non-inbred lines of rats have been tested for time required to show symptoms of A deficiency. Differences were noted but the variability was so great that the significance of these differences has not been established. As a crude working index for selection, the product of the grams gain and days to constant weight has been used. The particular inbred line showing the highest utilization index has been crossed with two other lines. The offspring in each case showed a considerably higher index than the other parent and approached the index of this particular line.

A number of a genetically "eyeless" strain of rats were divided into two groups and one group given a supplement of approximately 1200 U. S. P. units of vitamin A as Carotene-in-oil daily for 25 days prior to being placed with the male. The stock ration for both groups was Purina dog chow checkers. Pregnancy occurred on the average about 10-15 days after the males were placed with the females. The vitamin A supplement was continued until birth of the young. No significant difference was found in percentage of eyeless offspring in the two groups.

J. H. Quisenberry, F. Hale.

Cottonseed Meal As A Feed in Swine Nutrition

The object of this project is to determine if the presence of a toxic substance in cottonseed meal is the chief agent in restricting its use as a protein supplement for swine.

In this investigation preliminary work has included the development of extraction procedures and the building of laboratory scale equipment designed to produce samples of cottonseed meal under controlled cooking conditions. An additional qualitative color reaction for gossypol has been devised.

C. W. McMath, F. Hale.

Quantitative Requirements of Vitamin A for Pigs

Studies this year have been mainly concerned with trying out rations containing quantities of vitamin A for growing young Duroc gilts to maturity. These gilts will then be used to produce the pigs for the tests in which varying quantities of vitamin A are supplied to the several lots of individually-fed pigs. The gilts receiving a ration containing 100 micrograms of carotene in the form of alfalfa leaf meal per 100 grams

of feed show promise of developing normally under restricted dry lot conditions.

F. Hale, G. S. Fraps.

Oats and Sudan Grass Pasture for Fattening Hogs

The test with oats pasture this year resulted in a saving of 693 pounds of protein supplement and 748 pounds of grain per acre of oats pasture with 72-pound pigs fed for 90 days. The grain and protein supplement were self-fed, free choice. The average final weight of the pigs on oats pasture was 245 pounds, and for the dry-lot fed pigs, 238 pounds at the close of the 90-day test.

Due to drouth, no test with Sudan grass was conducted this year.

F. Hale.

Calcium Requirements of Pigs Fed Rations Balanced With Cottonseed Meal

The results of this year's work together with that of last year indicate that for fattening pigs a ration in which the protein supplement is cottonseed meal should contain from 1 per cent to 1½ per cent of oyster shell flour or its equivalent. The oyster shell flour used in these tests contained 54.57 per cent calcium oxide (CaO).

F. Hale.

Concrete Hog Wallows for Fattening Hogs

Last year's test with 20 individually-fed pigs resulted in 14 pounds more gain per pig in 90 days for the pigs that had access to a concrete hog wallow. This year, the pigs that had access to a concrete hog wallow made 18 pounds more gain per pig in a 90-day test than did the pigs where no hog wallow was used. All pigs were self-fed the same kind of feed. These tests were conducted during the months of June, July, and August, with an average temperature of 83° F.

F. Hale.

DAIRY HUSBANDRY

Milk Substitute vs. Skim Milk for Dairy Calves

(In cooperation with School of Agriculture, A. & M. College of Texas)

The work of this project was just recently started with the object of determining the value and economy of using a milk substitute in the raising of young dairy calves. There are approximately 40 calves on experiment at the present time but the experiment has not progressed far enough to present results.

O. C. Copeland and A. L. Darnell.

Methods of Manufacture and Other Factors Affecting the Quality of Butter

(In cooperation with School of Agriculture, A. & M. College of Texas)

The first part of the project consisting of a survey of butter plants in the state is still in progress. This survey consists of analyzing monthly

butter samples from a creamery in each of the several sections of the state. During the past year most of the creameries in the survey improved the quality and composition of the butter.

F. E. Hanson and C. N. Shepardson.

The Effect of Various Temperature Exposures on the Quality of Southern Short Cure Cheddar Cheese

(In cooperation with School of Agriculture, A. & M. College of Texas)

Preliminary work has indicated that 45° F. is too cold for short curing pasteurized-milk cheese as measured by chemical analysis. During the past year incubators and refrigerators for curing cheese at 45°, 60°, 70°, and 80° F. have been secured. In addition, other equipment has been added to the laboratory for a more complete analysis of the cheese.

F. E. Hanson and C. N. Shepardson.

Cottonseed Meal and Hulls as a Ration for Lactating Dairy Cows

This project has been completed and the data are being analyzed for publication as a Station bulletin.

O. C. Copeland.

Bang's Bacillus Disease (Bovine Infectious Abortion)

The dairy herd of the Feeding and Breeding Station has remained free of Bang's disease during the year. Complete information on breeding performance of the herd can be found in the report of the Division of Veterinary Science.

H. Schmidt and O. C. Copeland.

The Quantitative Requirements of Vitamin A for Dairy Cattle

This project has been continued as outlined in previous reports. Three groups composed of six heifers each have been fed on levels of 1000, 2000, and 2500 micrograms of crude carotene per 100 pounds liveweight since approximately five months of age. The results to date indicate definitely that even 2500 micrograms of carotene per 100 pounds liveweight of the animal does not supply enough vitamin A for young, growing dairy cattle to permit a normal production of milk and butterfat, for normal breeding performance, for normal vision, nor for a normal resistance against infection. Each of the two higher levels apparently supplied enough vitamin A for normal growth. These results indicate that other factors related to a deficiency of vitamin A in young dairy cattle deserve more attention than the growth factor.

Continuing the investigation to ascertain the effect of a deficiency of carotene on milk yield during a lactation, one experiment has been com-

pleted where alfalfa meal and carotene dissolved in wesson oil were compared as sources of vitamin A for milking cows. Greater production was secured using alfalfa meal as the source of carotene. This seems to indicate that other factors were concerned in our previous experiments where about 10 per cent more milk was secured when the cows were fed 15,000 micrograms of carotene as compared with 1,500 micrograms per 100 pounds liveweight and when alfalfa meal was used as the sole source of vitamin A activity. This point needs further investigation.

O. C. Copeland and G. S. Fraps.

New born calves from 14 heifers being used in our vitamin A studies have been submitted to the Division of Veterinary Science for pathological studies. Blood samples from heifers representing each level of carotene have also been collected and turned in to the Veterinary Division for pathological analysis.

H. Schmidt and O. C. Copeland.

Permanent Pastures for East Central Texas

Due to extremely dry weather only one clipping yield was obtained from the bermuda plats to which various fertilizer treatments had been applied. In previous years the plats treated with manure produced greater yields than plats treated with commercial fertilizers.

O. C. Copeland and E. B. Reynolds.

Variations in Normal Composition of Milk Produced in Texas

(In cooperation with School of Agriculture, A. & M. College of Texas)

Work on this project during the past year has been limited primarily to perfecting the various methods of analysis. The following methods have been adopted and satisfactorily standardized:

1. Butterfat—The Babcock method.
2. Total protein—The Micro-Kjeldahl method.
3. Casein—The A.O.A.C. official method, for precipitating the casein, followed by a nitrogen determination using the Micro-Kjeldahl procedure.
4. Lactose—The colorimetric picric acid method.
5. Ash—The A.O.A.C. official method slightly modified.
6. Titratable acidity—A.O.A.C. official method.
7. pH—Potentiometric method.
8. Chlorides—Modified Volhard titration method.
9. Total solids—The A.O.A.C. official method, slightly modified.

Actual work on the analysis of milk was begun in December 1939. Composite herd samples from the College Holstein and Jersey herds, and from two herds owned by local dairymen are being analyzed at two-week intervals.

T. R. Freeman and C. N. Shepardson.

Dried Citrus Peel and Pulp in Ration of Lactating Dairy Cows

(In cooperation with School of Agriculture, A. & M. College of Texas)

There have been two ninety-day experiments completed with each of the two dairy herds. A grain mixture containing 50 per cent citrus peel and pulp was compared with a similar grain mixture with the citrus being replaced by corn and cob meal. In the first tests completed with each of the dairy herds the two grain mixtures had about the same productive value for milk production. However, in the last experiments the corn and cob meal ration proved slightly superior to the citrus grain mixture. The citrus used in these last tests was less palatable than that used in the first experiments as indicated by a greater amount being refused. It will be necessary to repeat these experiments in order to secure more significant results.

O. C. Copeland and C. N. Shepardson.

POULTRY HUSBANDRY

Carotene Requirements of Hens

Two experiments were conducted in cooperation with the Division of Chemistry. In one experiment of three lots of hens receiving 150, 225 and 300 micrograms of carotene per 100 grams of feed, egg production was not very satisfactory on any of the levels and the mortality was rather high. These birds had been on experiment with these limited carotene intakes for two years previous to this experiment. The hatchability of the eggs was satisfactory on the 300 microgram level of carotene and unsatisfactory on the other two levels.

In an experiment with first year pullets on levels of 200, 400 and 600 micrograms of carotene per 100 grams of feed, egg production was higher than in the preceding experiment and was in direct proportion to the carotene intake. The hatchability of eggs was also directly correlated with the levels of carotene fed.

R. M. Sherwood and G. S. Fraps.

Protein Requirements of Chicks

The work in this Division, in cooperation with the Feed Control Service, showed that 18 per cent protein was the most satisfactory amount for growing chicks. The experiments included rations with concentrated protein feeds, largely of animal origin, and others largely of vegetable origin, but in all cases the results showed that the gains in live weight of the chicks increased with the increasing amounts of protein up to 18 per cent and only slight increases when more than 18 per cent was fed. This is in line with work of other Stations. In experiments with typical chick rations, no advantage in gains was secured by an added amount of vitamin G.

In another experiment liver meal did not give as rapid growth as did sardine meal.

F. D. Fuller, R. M. Sherwood, and J. R. Couch.

Effect of Sulphur Flour on Intestinal Cell Development in Chicks

In an experiment studying the effect of sulphur flour on the cell development of the intestinal tract of chicks, 5 per cent of sulphur flour was included in rations as compared with no sulphur flour. Some of the rations contained fish liver oil while some did not, and some of the chicks were exposed to direct sunlight while others were not. Histological studies showed that when 5 per cent of sulphur flour was included in the ration for chicks there was a retarded or restricted development of the duodenum, jejunum and caeca. Retardation of growth was more pronounced in the absorptive area of the alimentary channel than in other sections. Exposure to sunlight did not change the effect of sulphur on the development of cells in these regions of the digestive tract.

L. E. James.

Vitamin D Requirements for Chicks

In experiments conducted in cooperation with the Division of Chemistry, chicks were given access to $\frac{1}{2}$, 1, $1\frac{1}{2}$, 2 and $2\frac{1}{2}$ hours of direct sunlight per week between 10 in the morning and 2 in the afternoon. It was found that chicks receiving one hour of direct sunlight per week were receiving a sufficient amount for satisfactory growth, calcification of the bones, and maximum utilization of the feed.

Other experiments are under way to determine the percentage utilization of vitamin D from cod liver oil by growing chicks.

Two experiments were conducted this past year in cooperation with the Division of Chemistry to determine the effect of sulphur on the vitamin D requirements of chicks. When feed containing .50 per cent fortified fish oil containing 400 International Units of vitamin D per gram was fed along with 5 per cent of sulphur flour, there were no cases of rickets, but when the feed contained only .25 per cent of fortified fish oil, a number of chicks developed rickets.

J. R. Couch, G. S. Fraps, R. M. Sherwood.

RURAL HOME RESEARCH

Processing of Canned Meat

(In cooperation with the Division of Veterinary Science.)

Attempts have been made to obtain heating curves inside of sealed cans of meat by means of thermocouples. Considerable difficulty has

been experienced but the work is being continued with the collaboration of an electrical engineer.

Sylvia Cover, H. Schmidt, and R. D. Turk.

Chemical and Physical Factors Responsible for Tendering Meat During Cooking

Considerable time has been spent in having designed and built an oven in which the air flow over a roast may be controlled and in which the moisture loss during roasting may be obtained at suitable intervals without removing the roast from the oven. The oven is not yet completed.

Connective tissue is thought to be one of the factors responsible for toughness in meat. In the muscles the connective tissue is made up to a large extent of the protein collagen. There is no quantitative method available for determining collagen, so work is in progress with the aim of developing a satisfactory method for determining the collagen content of meat.

A manuscript under the title "Some Modifications of the Paired-eating Method in Meat Cookery Research" has been prepared and accepted for publication in *Food Research*.

Another manuscript is in preparation giving the results of tests for tenderness with extremely low oven temperatures.

Sylvia Cover.

Effect of Degree of Fatness on Tenderness of Lamb

(In cooperation with School of Agriculture, A. & M. College of Texas)

Before the lambs went on feed they were paired individually so that the pairs were as nearly comparable as possible in breed, body type, muscling, size, weight, and fleece. One lamb of each pair was placed in a lot receiving full feed in an effort to give them a high degree of finish. The other lamb of each pair was placed in a lot receiving a smaller amount of similar feeds sufficient only to keep them in a healthy and slightly gaining condition. Two pairs of lambs were killed at the same time—the full-fed ones being called "fat" on the hoof before killing. The one which was thin when killed was, as nearly as could be planned, thin because of limited feed only, and the other fat because of abundant feed only. In other words, the two lambs had the same predicted outcome on the same plane of nutrition. If inheritance of tenderness characters are linked with such external characteristics as breed, body type, muscling, size, and weight, then the pairs were well paired. If not, then inheritance of tenderness characters is an uncontrollable variable at present.

Each pair of lamb carcasses was stored in the same cooler for the same length of time before cooking. The legs from the left side were cooked and tested for tenderness by the paired eating method. Separable fat was

obtained for each wholesale cut in the right side of each carcass. It was expected that gradations such as those found last year would make possible sufficient data to determine how great must be the difference in fatness before a real difference in tenderness is obtained.

Such expectations were not fulfilled for when the data from this test were arranged in the order of the difference between each pair in the separable fat in the leg, a similar order is not apparent in the percentage of paired judgments in favor of the full-fed lot of lambs. In spite of this, it is nevertheless true that there is a significant number of judgments in favor of the fat lot of lambs (Tenderness-percentage 61, Chi-square 17).

Since there have been a significant number of paired judgments in favor of the fat lot of lambs in two separate tests carried on in different years and since the relationship between separable fat and the tenderness-percentage seems to be a doubtful one, it seemed advisable to look further into the data for other clues. The lambs in a pair had differed when killed in size, weight, and rate of gain as well as in fatness. The various pairs also had differed in length of time on feed. From growth curves of the paired lambs arranged in order of the tenderness percentages of the fat lambs, it was observed that the longer curves (lambs on feed longer) were scattered throughout the chart indicating no marked effect of length of feeding period on difference in tenderness between pairs. There was, also, no relationship between the weight at the end of the feeding period and tenderness, since the spread between the paired curves did not decrease with the tenderness-percentage. Differences in the rate of gain of the two lambs in a pair, which in some cases was rather marked, could not be used to explain the wide range in tenderness-percentage. The curves also showed clearly that the rates of gain of the two lambs in a pair were at times closer than had been expected. Group feeding was not a satisfactory practice with the paired lambs in this trial.

In the test which is now in progress paired twin lambs of the same sex and of approximately equal weight at the beginning of the test are being fed individually. One of each pair is being full-fed and the other limited fed. Results from this test are not yet available.

Sylvia Cover, A. K. Mackey, and C. E. Murphey.

Mineral Composition of Vegetables Grown in Representative Regions of Texas and the Relation of Variation in Mineral Content to the Probable Nutritive Value

(In cooperation with the Divisions of Horticulture and Chemistry and co-operative with other southern states, the U. S. Plant Breeding Laboratory in Charleston, S. C., Texas Technological College, Texas State College for Women, and University of Texas.)

Seven Tops turnip greens and Cream Crowder peas from a common seed source are grown by the Experiment Station at Iowa Park, Winter Haven

and College Station and by Texas Technological College, under specified different fertilizer treatments.

The Division of Rural Home Research has prepared for mineral analysis by the Division of Chemistry the 1939 crops produced by the Experiment Station—cowpeas from College Station, all turnip greens from Iowa Park and Winter Haven and all as yet ready to harvest at College Station. Incidentally, certain techniques have been studied with a view to economizing time in the procedure of drying the vegetables. Use of the trip balance weighing to ± 0.1 gram gave as precise results in the determination of moisture in the fresh material of both cowpeas and turnip greens as were obtained with an analytical balance. Moisture content of random samples taken from the well mixed turnip green leaves did not differ significantly from the moisture in samples composed of selected typical plants from the same experimental lot (fertilizer treatment). Random samples varying in size from 50 to 100 grams were as satisfactory as those ranging from 100 to 200 grams for determining total moisture.

Extensive referee work on methods has been done by the chemistry laboratories working with this project. A. O. A. C. methods have been chosen for calcium and phosphorus, but none for iron is yet agreed upon. The Division of Chemistry has completed determination of calcium and phosphorus in the 1938 crop of turnip greens from the three Experiment Stations. The average amount of calcium in greens on both fertilized and unfertilized plats was slightly higher (3.04 per cent fertilized, 3.32 per cent for unfertilized) in those grown at College Station than at Winter Haven (2.62 per cent fertilized and 2.75 per cent unfertilized). The phosphorus in College Station greens (0.67 per cent fertilized and 0.60 per cent unfertilized) averaged only little more than in those from Winter Haven (0.64 per cent fertilized, 0.59 per cent unfertilized). Iowa Park greens grown without fertilizer contained an average of 2.85 per cent calcium and 0.35 per cent phosphorus.

Jessie Whitacre, S. H. Yarnell, G. S. Fraps,
L. R. Hawthorn, B. S. Pickett.

Effect of Tea upon the Energy Metabolism of Children

The effect of caffeine on the energy metabolism of children 10 to 13 years of age is determined by comparing the increase in oxygen consumption over the basal rate caused by 300 cc. of ice tea (average amount caffeine .03 gram), with the increase following ingestion of 300 cc. lemonade containing the same amount of lemon juice and sugar. A Benedict-Roth recording respiration apparatus is used.

In the first series of experiments with 8 children who varied in habit of consuming foods containing caffeine and theobromine, none showed a consistently higher rate after tea, and very little increase due to caffeine was observed in any instance. In the second series with 8 children, (eight experi-

ments with each of six of them having been made in the summer of 1939), the factor of tolerance was taken into account. The child abstained from all foods containing caffein or theobromine for one to two weeks prior to first tests with tea. Subsequently, tests with both beverages were repeated following daily ingestion, for at least a week, of tea of the same strength as used in the experiments. Results in the second series are being analyzed and a complete report is in preparation.

Jessie Whitacre.

Study of Body Measurements for Sizing Children's Garments and Patterns

The first report, U. S. D. A. Miscellaneous Publication No. 365, has been published. The analyses presented are based on 4,917,052 body measurements taken on 133,807 American boys and girls of from 4 to 17 years. Of the total number, 7,560 were Texas children. Correlation coefficients, calculated for 190 pairs of 20 items—age, weight, and 18 body dimensions—show that age is the poorest predictor of body dimensions. The best predictor is either a combination of height and weight, or of height and hip circumference. Height-hip correlation is used for proposing for boys 14 each and for girls 12 each of "regular," "below regular," and "above" regular sizes for garments and patterns.

Analysis of the Texas data with special reference to socio-economic level and region of the children's homes is in progress by the Division of Rural Home Research. No conclusions are available, but some regional relationships have been noted. In general, the body dimensions of the Houston and San Antonio children at corresponding ages resemble each other as do those of the Lubbock and Denton-Dallas groups. Illustrating with the 9-year-old children of Lubbock and Houston, the girls of Lubbock are smaller in 18 of 19 measurements than those in Houston schools. Differences are statistically significant for weight, total stature, height of hips, and girth of waist, of hips, of thigh, of calf of leg, and of knee. Among 9-year-old boys in the same socio-economic group, those of Lubbock have the same average as Houston boys in two measurements, slightly greater in three measurements, and smaller in the remaining 13. Only girth of thigh, of calf of leg, and of knee was significantly less among the Lubbock boys.

Jessie Whitacre.

Physical Characteristics in Cotton and Their Interrelationship

Lightning Express and Half and Half, with succeeding generations of hybrid lines resulting from a cross of these two varieties were used. The cotton was furnished by the Division of Agronomy.

The properties measured for each parent and succeeding generation included number of locks per boll, quantity of fiber on seed, length, uniformity, fineness, strength, and thickness of cell wall or maturity of fibers.

The average number of locks per boll were Lightning Express 4.2, Half & Half 4.4, F₁ 4.3, F₂ 4.1, and back cross of Lightning Express x F₁ 4.2.

The mean length of the F_1 was approximately the same as the average of the parents. The mean length of the back cross of Lightning Express $\times F_1$ was identical with that of the Lightning Express parent. Eighty-four per cent of the F_2 plants had mean lengths greater than the mean of the two parents.

There were no significant differences in the maturity of the parents and hybrids.

The weights per inch of the two parents and their crosses showed Lightning Express to be both finer and more uniform in fineness than Half & Half. The F_1 generation approached the average of the fineness of the parents but was less uniform than either parent. The cross of Lightning Express $\times F_1$ was slightly finer than the Lightning Express but less uniform than either parent. Approximately one-third of the plants of the F_2 generation fell within the range of the finer parent, nearly one-eighth within that of the coarser parent and nearly one-half between the parents. The F_2 fibers were less uniform in fineness than either parent.

The weight of the lint and the number of fibers on the seed of the F_1 and F_2 generations were approximately the same as the average of the parents, and those of the Lightning Express $\times F_1$ were approximately equal to the average of the Lightning Express and F_1 . It was estimated that the average number of fibers on the seed of Lightning Express was approximately 59 per cent of the average number on the Half & Half.

The strength of the Lightning Express was approximately 82 thousand pounds per square inch, Half & Half 66, F_1 76, F_2 73 and Lightning Express $\times F_1$ 76.

The results of this study are being prepared for publication.

Mary Anna Grimes.

APICULTURE

The Apicultural Research Laboratory is located near San Antonio with a yard near Dilley and an outyard in cooperation at Roxton.

Activities of Bees

There is no division of agriculture more intimately related to the weather and the responses of plant and insect life to the various phases of weather than apiculture. As the hive, the dwelling place of a colony of bees, is not a residence, but an incubator, it is impossible to build a hive where the life activities of the bees can be constantly observed and yet not disturb the environment which controls the natural functioning of the bee colony. Before a complete understanding of the life activities of bees can be obtained the intimate relationship of bees to the effects of barometric pressure, light, especially infra and ultra vibrations, together with the minute

changes in temperature around the salient temperatures that control the action of bees must be secured. The year of 1939 throughout much of Texas was a period of extreme drought. This gave an opportunity seldom encountered by the experimenter in beekeeping. The beginning of the year was warm and dry. The colonies as a whole were low in stores as there was little fall honey flow in 1938. The drought prevented the winter annuals that give the bees their first pollen and nectar from appearing. February gave the first and about the only rain of consequence during the year. March was dry with abnormally high temperatures. The deficiency in rainfall which had existed for a year and five months together with undue high temperatures brought the mesquite trees into bloom far ahead of their normal time. The nectar flow began on April 9 and ended on April 29. In so far as can be found this is the earliest surplus honey flow of such dimensions on record. The average per colony was about fifty pounds and as the flow was so early that a normal worker force was not present, this flow was undoubtedly the heaviest mesquite flow on record. A very slight honey flow from horsemint occurred during the first part of May. No honey flows occurred during which a surplus was stored after that date, the normal date on which the first surplus should have commenced.

The entire summer and fall was one of drought and better than normal temperatures. This necessitated the bees living on this early stored honey throughout the remainder of the year. The high temperatures combined with a dearth of bloom caused the bees to continue their summer quiescence from the first of June through until the first of November when the desire for winter stores caused them to be quite active and quarrelsome as there was no possibility of any stores from the field.

The response of the bees to temperature was normal and for the first time here the response of the bees to a desire for water could be observed. It was found that when water became scarce the worker force would leave the hive early in the morning and individual bees would spend hours in an attempt to collect moisture from the drying beds of streams and ponds. This situation was relieved by the hauling of water to the bees.

H. B. Parks.

Adaptability of Native Plants

The ever-increasing interest in the use of native plants brought a heavy increase in the demand for information relative to such plants. The inability of introduced plants to meet the requirements of the growing drought caused many people to turn from introduced to native plants for ornamentals. The continued drought also enabled observations to be made on the plants that can stand drought and those that evidently have been introduced and become dominant, during humid periods that came to an end in 1935 and gave very valuable information as to the native plants that can be recommended for long time performance without regard to the extremes of weather.

Melilotus Alba, Var. Annua (Sweet Clover): The annual white sweet clover demonstrated its ability to stand considerable drought. This clover came into bloom the fifteenth of March, made some growth and was worked upon by the bees, however by the middle of April the plants blooming earlier had matured seed, and the entire plat died. Tests made since that time show that the soil has sufficient viable seed in it to reseed the plat whenever a sufficient amount of moisture falls.

Amoreuxia Wrightii A. Gray, first reported upon in 1938 will undoubtedly become an ornamental throughout the Gulf Coast region of Texas and probably farther north. So far as is known this plant was never collected in bloom in Texas and the first plants seen in bloom are those in the Laboratory plats. The plant comes from a perennial root and the parts above ground are inclined to be shrubby. It bears a yellow-red flower about two and one-half inches in diameter and the individual plants continue to bloom from May until September. As this plant is influenced by rainfall new blooms are produced after every rain. The plant has great possibilities as an ornamental and may have a commercial use. The tubers of a kindred species which occurs in north central Mexico form the plant food of the Indians of that section. All of the members of the family to which this plant belongs possess the dye material known as Arnotto. This is a yellow vegetable coloring matter largely used in the coloring of butter and cheese.

Amaryllidaceae: The study of this family continued and it becomes more interesting and of considerable importance as it proceeds. *Zephyranthes pulchella* is a tall growing yellow rain lily collected many years ago near Corpus Christi. A smaller species was recently collected in the same section and went on record as *Z. pulchella*, however in the summer of 1939 *Z. pulchella* answering the original description was collected in Gonzales and Kleberg Counties. From the size of this *Amaryllis* it will become a favorite with gardeners whenever there is a sufficient number of bulbs to allow its use. During September two lots of plants were collected on the Gulf prairie below Goliad, one of which is evidently a *Cooperia* but it is more beautiful and very different from any of the other Texas species. The other plant is closely related to *Cooperia* and *Zephyranthes* but is evidently of another genus. It also will make a fine ornamental due to the fact that it will grow and bloom in almost sterile soils.

The work of creating a supply of bulbs, seed, and plants of these rare species is receiving considerable attention. It is proposed that this material be distributed to plant fanciers and to commercial growers. The drought, however, of this summer has made this work difficult and in some cases the entire stock of certain species has been lost.

H. B. Parks, A. H. Alex.

Queen Rearing

The Laboratory strain of the Three-banded Italian bees has proved to be not only a superior honey gatherer but highly resistant to the severities of Southwestern weather. In addition three years of experiment have shown that it is able to protect its hive from the ravages of the wax moth far better than other strains of bees and especially the strains commonly used in the North. Very recently it has been found that this strain also possesses a high degree of resistance to American Foulbrood. During the year 1939 a sufficient number of queens was raised to requeen the hives belonging to the Laboratory and overwintering hives which contain the bees belonging to the Federal cooperative project discussed below.

A. H. Alex, H. B. Parks.

Queen Rearing for Resistance to American Foulbrood

(In cooperation with Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, and the Iowa and Wyoming Agricultural Experiment Stations.)

The work in 1939 was carried on in three different yards and planned so that a high percentage of pure mating occurred and so that line breeding could be practiced. Seven hundred sixty-eight queens of resistant stock were produced and shipped to cooperating agencies. Fifteen colonies containing selected queens for disease resistance were retained for starting the breeding work in 1940.

H. B. Parks and A. H. Alex.

Horsemint for Honey and Oil Production

The horsemint project has again during 1939 received sufficient attention to warrant some additional work in 1940. Due to a shortage of raw mint oil brought on by the war in the Far East and the Levant, the chemurgic organizations and the commercial druggists are on the hunt for a source of this material. Enough is known about horsemint to say that if there is a market for the raw oil and someone wishes to go into the business that they can make a fair profit by the cultivation of horsemint for its oils.

H. B. Parks, A. H. Alex.

Plant Survey of the State of Texas

The Plant Survey of the State is continuing. Large additions have been made to the report which is contained in Bulletin 550. Plants new to Science, new records for the State, and several new records for the United States, have been made during the year. A Progress Report on *Drymaria pachyphylla* Woot. & Standl. was distributed early in the year 1939.

H. B. Parks, V. L. Cory.

Plants for Tannin

Like horsemint, Canaigre is again being investigated as a source of tannin. A cooperative project with the Bureau of Plant Industry began in 1937.

The crop of 1938 was very short due to drought. The tubers harvested in September of that year were not sufficient for planting purposes, and plats were planted with the few tubers remaining from the Laboratory stock and tubers from farther west in Texas supplied by the Bureau of Plant Industry. These plants made a nice showing early in the spring but moisture was insufficient for any growth of tubers and the plants were apparently dead by the first of May. In September when the tubers should have been dug, there was not enough evidence to tell whether or not the tubers were alive; therefore it was decided to leave these tubers in the ground. Due to slight rains in December new leaves appeared and it was found that a very high per cent of plants are yet alive.

H. B. Parks, A. H. Alex.

The Genus *Rhus*

The sumacs are still attracting the attention of the Bureau of Plant Industry. Additional samples gathered from permanent plats on the Laboratory grounds and in the wild were made and shipped to the Bureau.

H. B. Parks, A. H. Alex.

AGRICULTURAL ENGINEERING

Mechanical Harvesting of Cotton

At College Station, 27 different strains, crosses, and varieties were tested with the Texas Station Cotton Harvester on September 4 and 5. For all the tests an average of 94.6 per cent of the cotton on the plants was harvested by the machine. The highest per cent, 98.3, was obtained in harvesting the Ducona 31 strain, while the lowest, 89.2, was obtained with the Half and Half x Acala cross. Ten strains of Ducona gave an average machine efficiency of 96.6 per cent, while six commonly grown varieties gave an average efficiency of 94.4 per cent.

At Lubbock in harvesting 19 strains, crosses, and varieties of cotton an average of 98.1 per cent of the cotton on the plants was harvested.

The grades of hand-picked, hand-snapped, and machine-harvested cotton at College Station averaged strict middling minus, middling minus, and strict low middling plus, respectively, while at Lubbock the average grades were good middling minus, strict middling shy, and middling plus, respectively. The differences between picked and stripped cotton were one and one-half grades at College Station and one and one-fourth grades at Lubbock.

From a varietal standpoint the grades of hand-picked cotton at College Station ranged from middling plus to good middling, and at Lubbock they ranged from strict middling to good middling. The grades of machine

stripped cotton at College Station ranged from low middling plus to middling plus, while at Lubbock the range was from middling to good middling.

In the breeding work at College Station, 13 crosses and 13 back crosses were made in an effort to combine plant and fiber characteristics which are suitable for mechanical harvesting, extracting, and cleaning. In addition to these crosses, about 50 selections were planted from which selfed seed were obtained for increased plantings in 1940. A similar number of crosses was made and selections planted at Lubbock.

Station Bulletin 580, "Mechanical Harvesting of Cotton as Affected by Varietal Characteristics and Other Factors," was published in December 1939. This bulletin discusses largely the various varietal characteristics and other factors that affect the efficiency of cotton harvesting, extracting, and cleaning equipment.

Snapping Qualities of Cotton Bolls: The average number of pounds required to pull open cotton bolls from the plants at College Station on August 15 ranged from 1.34 for D. and P. L. 11-A to 6.92 pounds for Ducona 39-10. On August 31, just prior to harvest, the pull ranged from 1.20 pounds for Cut Leaf x Acala to 7.63 for Ducona 17. The average of 22 varieties on August 15 was 3.83 pounds, while on August 31 it was 3.40 pounds. At Lubbock the pull required to remove cotton bolls ranged from .54 pound for Half and Half to 4.01 pounds for Ducona x Lone Star. The average of 19 varieties was 2.76 pounds.

Spread of Open Cotton Bolls: On August 15 it was found, by measuring, that the average spread of open cotton bolls at College Station ranged from 103 degrees for Mebane 140 to 137 degrees for Ducona 17. On August 31 the spread ranged from 92 degrees for Gorham's Lone Star to 125 degrees for Western Early. The averages for 22 varieties was 119 degrees on August 15 and 108 degrees on August 31.

At Lubbock the average boll spread on November 7 for 19 varieties was 103 degrees. The spread ranged from 80 degrees for Macha to 123 degrees for Ducona x Half and Half.

H. P. Smith, D. T. Killough, D. L. Jones, M. H. Byrom.

Efficiency in Distribution and Placement of Cottonseed and Fertilizer

Machine Placement of Fertilizer and Soil Disturbance Studies: This is the fourth year this experiment has been conducted at College Station and Nacogdoches. This year at College Station dry weather at planting time delayed germination on all tests.

Where the fertilizer was placed under the seed at depths of 1, 2, and 3 inches, fewer seedlings emerged than on the checks with the same soil disturbance at both locations. The four-year average is identical with the results for this year, except for the 3-inch depth at College Station where the average is greater for the fertilized row than for the check.

For the side-placement tests at College Station, more seedlings emerged on the fertilized rows than on the checks in all tests with one exception, and in this case there was a difference of only four plants between the test and the check. The results at Nacogdoches were the reverse of those at College Station, as more seedlings emerged on the checks than on the fertilized rows. The results for four years at both locations show that more seedlings emerged on the fertilized rows than on the checks with the same soil disturbance.

The yields for the placements under the seed increased as the fertilizer was placed deeper at both College Station and Nacogdoches. Placing the fertilizer 2 inches to each side and 1, 2, and 3 inches below the seed level gave higher yields as the depth increased at Nacogdoches, but no significant differences were obtained at College Station for the three depths.

Width of Furrow Openers: Cottonseed planted in a narrow furrow made by a narrow shovel about $1\frac{1}{2}$ inches wide gave better stands and yields than that planted in a wide furrow made by a $3\frac{1}{2}$ inch shovel.

Effect of Press Wheels: Tests were planted where no press wheel was used, a rubber-tired wheel was used before covering, a regular open-center steel wheel after covering, a rubber-tired wheel before covering, an open-center steel wheel after covering, and a narrow wood wheel after covering. This year the best stand was obtained when the rubber-tired wheel was rolled on the seed before covering.

H. P. Smith, M. H. Byrom.

Treatment of Cottonseed for Planting Purposes

The object of this experiment is to determine the effect on germination and yield of treating acid-delinted and non-delinted cottonseed with Ceresan, lime, and sulphur. The test has been conducted at both College Station and Nacogdoches for four years. At College Station, Ceresan-treated fuzzy non-delinted and acid-delinted seed gave significantly better stands than the untreated fuzzy and delinted seed. This is in line with the average for four years. Better yields were obtained with the Ceresan-treated acid-delinted seed than for the untreated delinted seed. The untreated fuzzy seed gave slightly higher yields than the Ceresan-treated seed. Treatment of fuzzy and delinted seed with lime or sulphur did not increase the stand or yield over the untreated tests. At Nacogdoches, untreated fuzzy seed gave a better stand than the Ceresan-treated seed. The Ceresan-treated acid-delinted seed, however, gave better stands than the untreated seed. For the four years, 1936-1939, the Ceresan-treated fuzzy and delinted seed gave the best stands. Sulphur treatment of acid-delinted seed gave stands almost equal to those of the Ceresan treatment, but sulphur-treated fuzzy seed gave the lowest stand of the three treatments. Of all the treatments, the sulphur-treated fuzzy and acid-delinted seed gave the highest yields in 1939. This is also true for the four-year averages.

H. P. Smith and M. H. Byrom.

Atmospheric Exposure of Wire and Fencing

(In cooperation with the American Society for Testing Materials.)

The only visible change in the exposed specimens is a slight increase in the weathering of the galvanized zinc-coated samples. No samples were returned for tensile strength tests.

H. P. Smith and M. H. Byrom.

Garlic Drying

Three replications of nine treatments of garlic were planted at Moulton on November 15, 1938 and harvested from May 15 to 25, 1939. The garlic from each replication was treated differently: One was dried in the drier for 18 hours at an average temperature of 113° F.; one was dried on wire shelves under a canvas shade for 8 days; and one was left in the field for 9 days, exposed to the weather according to the practice of some growers.

The average loss from drying and cleaning was 7.0 and 9.1 per cent, respectively. The loss from shrinkage and decay while in storage for 99 days averaged 31.1 and 8.3 per cent, respectively.

The garlic, when graded, averaged approximately 60 per cent U. S. No. 1, 30 per cent U. S. No. 2, and 10 per cent culls.

The effect of the various chemical treatments is reported by the Division of Plant Pathology and Physiology.

H. P. Smith and G. E. Altstatt.

WILDLIFE RESEARCH

(In cooperation with the Fish and Wildlife Service, U.S.D.I., the American Wildlife Institute, the Texas Game, Fish and Oyster Commission, the School of Agriculture, and the Extension Service, A. and M. College of Texas.)

County Wildlife Resources Surveys

This project, designed to afford thoroughgoing information on the basis of which sound plans for wildlife management can be developed, calls for intensive studies of 17 counties in the 11 major ecologic types in the State, not counting the important alluvial types. Work is completed or in progress in 6 of the 17 counties. These are, in order of their being given attention, Walker, Kerr, Colorado, Harris, La Salle, and Culberson.

Walker County: First draft of the manuscript embracing the results of field work is well on the way to completion.

W. P. Taylor and Daniel W. Lay.

Kerr County: No field or office work has been done on this project during the year.

Tarleton F. Smith, Daniel W. Lay, W. P. Taylor.

Colorado County: Some further field work was done during the year and plans made for writing up the results of the survey.

V. W. Lehmann, H. R. Siegler, and T. T. Waddell.

Harris County: Game and wildlife conditions in this large county are of particular interest, not only because of the size of the county (1,058,560 acres), but because the city of Houston occupies so large a part of it. A vegetative type map of the county has been completed, a considerable number of headquarters areas installed for quail, and a game survey made. The most promising species is the bobwhite quail. Deer and wild turkey are being gradually crowded out. The gray fox is increasing. The gray squirrel is giving way in competition with the fox squirrel, and both are much reduced. The Attwater prairie chicken is reduced to a remnant of its former numbers. There are a few muskrats in the county but the species will probably decrease because of steady encroachment on its habitat.

Tarleton F. Smith and B. E. Ludeman.

La Salle County: When summer field work was brought to a close on August 31, 1939, specimens of 50 reptiles, 64 mammals, and 109 birds had been taken for the Texas Cooperative Research Collection at A. and M. College. A map of the vegetation types was made to facilitate plans for game management. Winter field work conducted in the county between November 30 and December 4 showed 26 species of mammals and 78 of birds present in the county. The anticipated quail increase did not materialize, perhaps because of the continuance of the drought.

B. E. Ludeman, T. F. Smith, and W. P. Taylor.

Culberson County: Field work was initiated in Culberson County June 10, 1939. Birds, mammals and reptiles taken for the Texas Cooperative Research Collection in June totalled 150. Notable takes included the purple martin and flammulated screech owl, taken in The Bowl, altitude 8,200 ft., Guadalupe Mountains, and the spotted owl, taken for the first time in Texas. Special attention was given the status of the Texas bighorned sheep. Fifteen new kinds of birds and seven of mammals were added to the College collection.

W. B. Davis.

Quail Management in Texas

Winter food of bobwhite, scaled and Gambel quail (in cooperation with the Texas Game, Fish and Oyster Commission): Further analysis of 2,319 winter stomachs of bobwhites, scaled quail and Gambel quail from various regions of Texas showed the importance of *Croton capitatus*, *C. engelmanni*, *C. texensis*, *Panicum texanum*, *Sorghum* sp., *Zea mays*, *Sesbania* sp., and *Bumelia lanuginosa* in the diet of the bobwhite. Most popular foods for the scaled quail were *Adelia angustifolia*, *Acacia roemeriana*, *Amaranthus blitoides*, *Prosopis glandulosa*, *Acacia constricta*, unidentified *Compositaceae*, and *Sorghum vulgare*. The Gambel quail fed principally on

Strombocarpus sp., *Croton punctata*, and an unidentified black-eyed pea. A progress report is being prepared covering the results of the study.

V. W. Lehmann.

Cover control to influence food and shelter for quail: Census of the bobwhites on 1,800 acres of land on the farm, Texas Agricultural and Mechanical College, (post oak woodland, including pastures and a small amount of cultivated land) has showed results as follows:

Date of Count	Coveys	Quail	Acres per Quail
November, 1936.....	12	142	12.67
November, 1937.....	17	184	9.78
November, 1938.....	12	156	11.54
March, 1939	10	115	15.65
November, 1939.....	8	81	22.22

This area is not hunted. Evidently the numbers, both of coveys and individual birds, vary in accordance with food, cover, climate, or other factors, independent of protection. An attempt will be made to further analyse these factors.

Eight experimental plots were established in Pasture 9, and different treatment provided to ascertain procedures that might be feasible for quail encouragement in post oak pastures. There was a 1,400 per cent increase in *Croton capitatus* in plowed plots, but the season was too dry to produce much feed on planted plots.

H. C. Hahn.

Quail Management in the Coastal Plains and Prairie Regions of Texas (in cooperation with the Texas Game, Fish and Oyster Commission): Further work on the installation of artificial quail covey headquarters areas (food patches, brush shelters, and 12 foot fenced areas), located in Wharton, Matagorda, Goliad, Colorado, and Harris counties, showed 63 out of 100 in use by coveys of quail; 37 were unoccupied. Twenty-nine of 43 shelters in Harris County were being used by bobwhites, in an area where, in March, 1939, the quail population was but one quail per 350 acres.

V. W. Lehmann.

Genetic Experiment: An experiment was begun to test the effects on sex ratio, vigor, color, and general characteristics of hybridizing the Texas bobwhite (*Colinus virginianus texanus*), and the Virginia bobwhite (*C. v. virginianus*). There was one F₁ mating made from birds raised in 1938, but none of the offspring are living; the birds were sexed during a post mortem examination of each bird, however. Of the 24 quail hatched from this mating the sex ratio was 1:1. There was nothing unusual in the sex ratio from the offspring of the other matings. Fourteen of the 17 pairs of quail were laying in June and 260 eggs were being incubated by the 27th of that month. Quail hatched after July 10 seem to be more vulnerable to disease than birds hatched prior to that date. It is evident

that late hatched birds are harder to rear than those hatched earlier in the season. The climate may be the limiting factor.

Italian rye grass, planted under the hardware cloth which is used for flooring, furnishes plenty of good green grass all during the winter and spring months. Oats may be used along with the rye grass or as a substitute.

E. H. Roesner and D. H. Reid.

Ecological Wildlife Relationships

Dates of Plant Development and Availability: Weekly field observations made at College Station, Texas, between September 1, 1936, and April 1, 1938, disclosed seven distinct waves of vegetation. These waves are devices on the part of the plants to avoid competition by dividing up of the year among them. Plants flowering in spring are most numerous but seemingly not so important as food sources for bobwhite quail as those flowering in summer, which include the partridge pea, three kinds of crotons, and the knotweed. Although possessing the shortest periods of seed dissemination of any of the plants observed, the crotons are of outstanding importance, as subsequent to dissemination the seeds accumulate and remain for months on or close to the soil surface. Close analysis of the periods of growth, blooming, and especially seed maturing and seed dissemination of all the game food and shelter plants of an area is an essential for adequate wildlife management, which must insure a year-long supply of food and cover plants, with special attention to critical periods.

Tandy P. Chenault.

Present Status and Needs of Threatened Species in Texas

Texas Bighorned Sheep: Occurrence of bighorn sheep in favorable counties in the trans-Pecos is inversely correlated with the numbers of domestic sheep, suggesting some serious form of interspecific competition. Seemingly over-hunting, or predators are of little significance in relation to the small numbers of bighorns. The possible role of disease has not been ascertained.

W. B. Davis and W. P. Taylor.

Wildlife and Farming Practices in Eastern Texas

Costs of clearing, combined with a less favorable terrain and not so fertile a soil, make it impossible for some farms in eastern Texas to compete, in the production of cotton and certain other field crops, with those of the blacklands and other areas in the State. On the other hand, the region is admirably suited by nature to the production of a number of natural or semi-natural crops, including timber, pulp wood, game, fur animals, and perhaps range livestock. While much emphasis is being placed on pasture improvement for livestock, little thought has been given the natural crops.

In 1938 the cash value of the cotton crop in Polk County to the average farmer was \$3.73, including AAA payments. In this same county the average income to labor in handling timber was \$2.16 per acre. The annual stumpage return of \$1.09 per acre in addition makes \$3.25. Proper management of eastern Texas lands may produce an annual crop of furs, meat, and game birds. One Mississippi farmer made \$1.18 per acre on bottomland over a 5 year period from furs, including raccoons, minks, and opossums. Even on uplands some return from this source is possible. Grazing should be expected to return at least 25 cents per acre except on the poorest ranges. Obviously the potential total from natural crops may definitely exceed that from field crops. A trial total on bottomlands indicates a possible income from natural crops of \$4.68. On uplands the increase would be less, of course. Avoidance of erosion and prevention of wasteful and unnecessary clearing also indicate the desirability of making maximum use of the natural crops. At the very least the possibilities are sufficiently promising to justify a good deal of further research work.

W. H. Kellogg.

Beaver Restoration

Two subspecies of beaver remain in Texas, *Castor canadensis texensis*, found in the Edwards Plateau area, the Panhandle, and eastern Texas, and *Castor canadensis mexicanus*, occurring along the Rio Grande. The present project concerns the Texas beaver of which there are probably not more than 500 individuals remaining in the State. Most of these are confined to the hill country, where they are found on the Llano River and its tributaries, although there are colonies on the Pedernales River, Gillespie County; Holmes Creek, Coleman County; Sweetwater Creek, Wheeler County; Wolf Creek, Lipscomb County; and the vicinity of Jasper, Jasper County. Forty-five beavers have been live-trapped where they were thought to be doing damage and liberated where they were desired in other parts of their former range, chiefly in eastern Texas. Here they have become established on all sites selected in the light of beaver requirements for food, water and protection, and in at least two instances the animals are known to have increased. In one instance three dams have been built, and in another four. Suitable sites for beaver liberation must have both woody and herbaceous vegetation. Beavers will feed on birch, oak, pine, cedar, pecan and many other woody species. Willow is a staple food. Any representative of the genus *Populus* is readily accepted. There must be an abundance of herbaceous vegetation also, as beavers feed on such growth throughout the year, except for a short period between late February and early April. The work has gone far enough to demonstrate the feasibility of beaver restoration in this State.

A. H. Cook.

The Mammals of Texas

The major portion of time allotted to this project has been spent on field work, including the collection of specimens and information, and to a

study of the distribution, relationships, and ecology of the pocket gophers of the genus *Geomys*. Part of the manuscript has been prepared for a proposed book on Texas mammals.

W. B. Davis.

The Pocket Gophers of Texas

A critical study of the distribution and relationships of the pocket gophers, genus *Geomys*, in Texas, reveals the presence of three well marked species. *Geomys breviceps* and its subspecies occupies the coastal plain of Texas largely east of the Balcones escarpment; *Geomys lutescens* occurs on the higher plains of Texas from Gillespie County north and west; *Geomys personatus* is restricted to the lower Rio Grande plains from near the Nueces River south to the Rio Grande. Each of these species is restricted almost exclusively to deep sandy soil. This is not true of the other genera of pocket gophers, *Thomomys* and *Cratogeomys*, in Texas. Seven subspecies of pocket gophers have been described as new.

W. B. Davis.

The Fishes of Texas

A study of the summer food habits of 271 gars in the waters of the Guadalupe River, Kerr County, showed that suckers and sunfishes constituted the chief diet of the gars examined, no bass being found. Collections of fishes are being made widely over the State with a view to publishing a "Fishes of Texas." An American Wildlife Institute contribution permitted the undersigned to work for a period of six weeks last summer in the museum of fishes at the University of Michigan. The time was largely devoted to a study of Texas fishes, of which the largest collection in the world is at that University.

K. Bonham.

Habits of the Armadillo

That armadillos perform some valuable functions is not especially new. It is known, for example, that they destroy ants, some of which are inimical to bobwhite quail when they are hatching. It perhaps has not been recognized heretofore, however, that like the woodchuck in Pennsylvania the armadillo may serve a valuable function in excavating dens which may later be used by game or fur animals. In 51 dens excavated by Daniel W. Lay and the undersigned, there were found cotton rats, cottontails, opossums and skunks. Five different armadillo dens contained cottontails, and as many opossums were found inhabiting armadillo dens as armadillos themselves. So far as known, cottontails and opossums do not dig burrows for themselves. It would not be surprising to find that in some places, the armadillo permits the substantial increase of these animals. Each Texas armadillo usually has from 4 to 8 dens, some in use, some not. Regardless of the status of the burrows, all are excellent potential retreats for valuable fur bearers.

F. W. Taber.

FEED CONTROL SERVICE

Inspection

The usual inspection of feeding stuffs has been continued during the past year and eight inspectors have visited feed manufacturers, feed dealers, and a considerable number of consumers in order to secure official samples for analysis and to detect possible violations of the Texas feed law. Each inspector is required to file at the office each week an itinerary which is subject to revision if considered advisable. In addition he is required to submit a daily report of his activities. During the period covered by this report the inspectors have traveled 112,346 miles in the performance of their official duties and visited 20,406 firms in 4,470 towns and cities. Several trips were made from the office for the purpose of carrying on special investigations.

Computed from the sale of feed inspection tags there were 1,697,189 tons of feed sold in the State during the fiscal year ended August 31, 1939. This amount represents only the tonnage of feeding stuffs regulated by the Texas feed law, and is based on the assumption that all the tags sold during this period were used for feeds sold during that period. The 1938-39 sale of feeding stuffs in Texas is the largest on record and has steadily increased during each of the past seven years with one exception. Cooperation with the Food and Drug Administration of the U. S. Department of Agriculture has been continued and thus control exercised over interstate shipments of feed as further protection to Texas purchasers.

Samples

During the fiscal year the inspectors secured 3,524 official samples of feed, which were subjected to chemical analysis and microscopic examination by the Division of Chemistry. In addition to these, there were analyzed a few registration and special samples, making a total of 3,613 samples analyzed during this period. In addition, twenty-six samples of fish liver oils and fortified fish liver oils were assayed for vitamin D potency, and twenty-four samples of cottonseed cake were tested for hardness. Three hundred and thirty-eight determinations of salt and two hundred and forty-four determinations of carbonate of lime in mixed feeds were also made.

Reports

The results of inspections and analyses are reported to the manufacturer, dealer, and consumer as soon as practicable after the results are available. When a shipment appears to be adulterated or misbranded, the dealer is notified and advised to remove it from sale until the matter has been satisfactorily adjusted.

Shipments Withdrawn from Sale

During the year covered by this report dealers were advised to remove from sale 645 shipments of feed, manufactured by 264 different firms totaling 1,640 tons. These shipments were withdrawn from sale because they did not meet the requirements of the law. Untagged shipments were properly labeled with tags furnished by the manufacturers; improperly labeled shipments were relabeled with official tags properly printed, or with tags showing guaranties that could be maintained, and in still other cases shipments were returned to the manufacturer. The sales of goods below guaranties were adjusted, in practically all instances, by manufacturers paying refunds to dealers and consumers when the deficiencies were sufficient to warrant such action. In all cases where refunds were made to dealers, the dealers were advised to prorate the same to their customers in so far as possible, so that the ultimate consumer would receive its benefit.

Violations

During the year seven complaints were filed with County Attorneys against manufacturers violating certain provisions of the Texas feed law. Five of these cases were settled by payment of fines and docket costs, and two cases were placed in abeyance pending future compliance with the law. Four firms were cited for hearings to be held in the office of this Division for the purpose of presenting evidence to show cause why they should not be prosecuted for violating the law and each of these firms sent representatives to the hearings. Upon presentation of the evidence such action was taken as seemed advisable. Six hundred and forty-one minor complaints were adjusted through correspondence, together with the assistance of the inspectors. These complaints consisted of untagged shipments of feed; improperly labeled shipments; incorrectly printed tags attached to packages of feed; short weights; deficiency in crude protein; excess of crude fiber, and other minor irregularities.

During the year there were thirteen Federal cases developed against manufacturers shipping feed into this State in violation of the Food and Drugs Act of 1906. The necessary evidence in each case was transmitted to Federal authorities for legal action. These cases were then referred to United States attorneys having jurisdiction and prosecution of violators recommended. Five of the cases were terminated by payment of fines and costs. Eight cases are now pending.

Hardness of Cottonseed Cake

The determination of the hardness of cottonseed cake has been continued during the past year. Twenty-four samples representing the output of twenty oil mills were tested for hardness and the crushing strength varied from twenty-two pounds, soft, to 1,891 pounds, hard. Most of the samples examined, however, were classified as soft.

Cooperative Research Projects

Allotments of funds of the Division for research projects to assist in the proper and adequate administration of the Texas feed law have been made to the following:

Division of Chemistry

Chemical Analyses and Investigations of Commercial Feeds
Vitamins in Commercial Feeds

Division of Poultry Husbandry

Protein Requirements for Chick Rations
Maximum Crude Fiber Content of Chick Starters

Division of Veterinary Science

Testing Manufactured Feed Samples for Poisons or Other Harmful Substances

F. D. Fuller and James Sullivan.

PUBLICATIONS

During the fiscal year, September 1, 1938 to August 31, 1939, the Division of Publications edited and received for distribution 10 bulletins, 3 circulars and the Director's 50th annual report. The 51st report was received from the printer after the close of the fiscal year and will be reported later. Members of the Station staff reported publication during the fiscal year in various scientific journals of 64 technical papers which they had prepared. They, also, reported 178 popular papers prepared for publication in various current journals and newspapers. There were 84 Progress Reports reproduced in this division and mimeographed for dispatch to the press and various agricultural workers including the Extension Service workers and the Smith-Hughes vocational teaching staff. A few of these Progress Reports were prepared at the Substations or in the divisions and comprise several pages. These have had only limited distribution, but a supply is maintained to fill requests. The stencils of all the Progress Reports are preserved and copies are at all times available to fill requests.

The Annual Abstract Circular, No. 83, was prepared in this division and carries abstracts of bulletins 558-566 inclusive, circulars 81 and 82, as well as the Director's 50th Annual Report for the year 1937, and the report of the soil surveys of Williamson and Bee Counties, Texas. The circular carries abstracts of 42 articles that appeared in scientific journals and cites 107 popular articles by members of the staff which were published during the calendar year 1938. The publication of 96 mimeographed Progress Reports is cited and abstracts of the bulletins, circulars, and technical articles published during the year 1938 are included in this circular as is a list of available publications including mimeographed Progress Reports. Some 50 of the Progress Reports were read over the Texas Quality Network through the College broadcasting station, WTAW. The circular was printed in an edition of 68,000 copies, and sent to the entire station list.

A total of 180,947 publications were distributed during the year leaving on hand in the mailing room 830,517 copies available for free distribution.

The technical papers are listed and the Journals carrying them are cited and the bulletins, circulars and reports published from September 1, 1938 to August 31, 1939 are presented in a table as follows:

Technical Papers

384. "The Effect of Thrips Injury on Production in Cotton" by R. K. Fletcher and J. C. Gaines. Jour. Econ. Ento., 32(1):78-80, incl., 1939.
395. A Review of Chromosome Numbers in the Hemerocallideae, Alstroemeriales, and Amaryllidales; W. S. Flory and S. H. Yarnell. Herbertia (Yearbook of American Amaryllis Society), pp. 163-181, 1937.
396. Notes on Ephedra in Texas; V. L. Cory. Rhodora, vol. 40, pp. 215-218, 1938.
403. Methods for Determining the Physical Characteristics of Cotton Fibers; Mary Anna Grimes. Journal of Home Economics, vol. 29, No. 8, p. 572, 1937.
418. Report of the Referee on Fertilizers; G. S. Fraps. Journal of Association of Official Agricultural Chemists, vol. 21, pp. 257-258, 1938.
419. Life History and Control of *Phthia Picta* Drury on Tomatoes; S. E. Jones. Journal of Economic Entomology, vol. 31, No. 1, pp. 127-128, February, 1938.
421. Lechuguilla (Agave Lecheguilla) Poisoning in Sheep and Goats; Frank P. Mathews. Journal of the American Veterinary Medical Association, vol. 46, No. 3, pp. 168-175, September 1938.
425. Phosphoric Acid, Lime, and Protein in Forage Grasses of the East Texas Timber Country; G. S. Fraps and J. F. Fudge. Proceedings of Soil Science Society of America, vol. 2, pp. 347-351, 1938.
427. Report—Machine Placement and Soil Disturbance Studies in Texas in 1937; H. P. Smith. Proceedings of the 13th Annual Meeting of the National Joint Committee on Fertilizer Application, pp. 73-74, Nov. 29, 1937.
430. The Relation of Wind Currents, as Indicated by Balloon Drifts, to Cotton Flea Hopper Dispersal; J. C. Gaines and K. P. Ewing. Journal of Economic Entomology, vol. 31, No. 6, pp. 647-677, 1938.
431. A Review of Muscoid Genus *Eumacronychia* with Key and Descriptions of New Species (Diptera); H. J. Reinhard. Jour. N. Y. Ent. So., 47:57-68, incl., March 1939.
433. Insecticide Tests for Control of the Cotton Bollworm in 1936; R. W. Moreland and J. C. Gaines. Jour. Econ. Ento., 32(1):104, 1939.

438. Analysis of Data in Plat Designs for Cotton Insect Control; J. C. Gaines. *Journal of Economic Entomology*, vol. 31, No. 6, pp. 656-659, 1938.
439. Recent Field Tests of Insecticides for the Control of Cotton Bollworm; R. W. Moreland. *Journal of Economic Entomology*, pp. 666-668, 1938.
440. Some Factors Contributing to Tomato Puffing; Taubenhaus, J. J. and G. E. Altstadt. *Plant Physiol.* 14: 575-581. 1939.
442. Linkage of the Q B Gs Group in Sorghum; J. C. Stephens and J. R. Quinby. *Journal of Agricultural Research*, vol. 57, No. 10, pp. 747-757, Nov. 15, 1938.
443. Insecticide Tests for the Control of the Cotton Bollworm in 1936; R. W. Moreland and J. C. Gaines. *Journal of Economic Entomology*, vol. 32, No. 1, pp. 104-106, February 1939.
444. The Digestibility of Carotene by Rats and Chickens; A. R. Kemmerer and G. S. Fraps. *Journal of Nutrition*, vol. 16, No. 4, pp. 309-315, October 10, 1938.
447. The Vitamin C Content of Some Texas Fruits and Vegetables; W. W. Floyd, and G. S. Fraps. *Food Research*, vol. 4, No. 1, pp. 87-91, 1939.
451. Cytotaxonomic Notes on the Genus *Habranthus*; Walter S. Flory. *Herbertia*, vol. 5, pp. 151-153, 1938.
452. The Evaluation of the Vitamin A Potency of Feeds; G. S. Fraps. *Industrial and Engineering Chemistry*, vol. 10, No. 9, pp. 525-527, September 15, 1938.
453. A Mixture of Sulphur and Calcium Arsenate Recommended for Control of the Cotton Flea Hopper and Boll Weevil; K. P. Ewing and R. L. McGarr. *Bureau of Entomology and Plant Quarantine, Circular E-430*, April 1938.
456. Comparative Studies on the Chromosome Numbers in Sheep, Goat, and Sheep x Goat Hybrid; R. O. Berry. *Journal of Heredity*, vol. XXIX, No. 9, pp. 343-350, September 1938.
458. Beef Cattle Investigations Relating to the Fattening of Steers at Different Levels of Feeding; J. M. Jones. 15th Annual Report of the National Livestock & Meat Board, p. 102-103, 1938.
459. The Effect of Degree of Fatness on Tenderness and Flavor of Lamb; J. M. Jones. 15th Annual Report of the National Livestock & Meat Board, p. 106, 1938.
462. Replacement of Calcium in Soils by Sodium from Synthetic Irrigation Water; G. S. Fraps and J. F. Fudge. *Journal of the American Society of Agronomy*, vol. 30, No. 10, pp. 789-796, October 1938.

464. New Genera and Species of Muscoid Diptera; H. J. Reinhard. Brooklyn Entomological Society Journal, vol. 34, No. 2, pp. 61-74, April 1939.
465. Growth of Phymatotrichum Omnivorum in Solutions with Varying Amounts of Certain Mineral Elements; C. H. Rogers. American Journal of Botany, vol. 25, No. 8, pp. 621-624, October 1938.
468. Berberine as a Factor in the Resistance of Mahonia Trifoliolata and M. Swaseyi to Phymatotrichum Root Rot; Glenn A. Greathouse and G. M. Watkins. American Journal of Botany, vol. 25, No. 10, pp. 743-748, December 1938.
469. Lengthening the Cucumber Season; Jessie Whitacre, S. H. Yarnell, and L. R. Hawthorn. Journal of Home Economics, vol. 30, No. 8, p. 586, 1938.
471. Vitamin A Requirements for Fattening Beef Cattle; J. M. Jones. Report of Chief of Bureau of Animal Industry, p. 17, 1938.
472. Feeding Problems Affecting Beef Production; J. M. Jones. Report of Chief of Bureau of Animal Industry, p. 17, 1938.
473. Effect of Phosphates on Nitrifying Capacity of Soils; G. S. Fraps and A. J. Sterges. Soil Science, vol. 47, No. 2, pp. 115-121, February 1939.
474. The Control of Nut-Grass with Chloropicrin; G. H. Godfrey. Soil Science, vol. 47, No. 5, pp. 391-395, May 19, 1939.
475. Cotton Root Rot in Texas in 1937, and Conditions Affecting Its Local Prevalence; Walter N. Ezekiel. Plant Disease Reporter, vol. 22, pp. 315-324, August 1938.
477. The Relation of Moisture and Temperature to Growth of the Cotton Root Rot Fungus; C. H. Rogers. Journal of Agricultural Research, vol. 58, No. 9, pp. 701-709, May 1, 1939.
481. Perfect Flowered Buffalo Grass, Buchloe Dactyloides; R. L. Hensel. Journal of the American Society of Agronomy, vol. 30, No. 12, pp. 1043-1044, December 1938.
482. Gallatin Fossil Forest; P. A. Young. American Journal of Botany, vol. 25, No. 10, p. 9, 1938.
483. Report of the Referee on Fertilizers; G. S. Fraps. Journal of the Association of Official Agricultural Chemists, vol. XXII, No. 2, pp. 252-254, May 1939.
484. White Rust of Spinach; S. S. Ivanoff. Phytopathology, vol. 29, p. 12, 1939.

486. The Relation of Nitrogen, Phosphoric Acid, and Lime in the Soils of East Texas to Those Constituents in Bermuda and Little Bluestem Grasses; J. F. Fudge and G. S. Fraps, Division of Chemistry. Soil Science Society Proceedings for 1938, 189-194. 1939.
487. Improved Method for Estimating Carotene in Feeds; G. S. Fraps and A. R. Kemmerer. Journal of the Association of Official Agricultural Chemists, vol. 22, No. 1, pp. 190-195, February 1939.
488. Progress in Mechanical Harvesting of Cotton; H. P. Smith. Agricultural Engineering, vol. 19, No. 9, pp. 416, September 1938.
489. Report—Effect of Machine Placement Versus Soil Disturbance on Cotton; H. P. Smith. Proceedings of 14th Annual Meeting National Joint Committee on Fertilizer Application, pp. 34-35, December 1938.
490. Brown Necrosis, A Discoloration Associated with Rust Infection to Certain Rust Resistant Wheats; E. S. McFadden. Journal of Agricultural Research, vol. 58, No. 11, pp. 805-814, June 1, 1939.
491. Controlling Damping-off Diseases of Tomato Seedlings with Light, and Chemicals on the Seed and Soil; P. A. Young. American Journal of Botany.
494. Carotene Requirements for Fattening Beef Cattle; J. M. Jones, J. K. Riggs, G. S. Fraps, J. H. Jones, H. Schmidt, R. E. Dickson, Paul E. Howe, and W. H. Black. Proceedings of the American Society of Animal Production, 1938.
495. New and Little Known Phyllophaga from Texas, (Scarabaeidae, Coleoptera); H. J. Reinhard. Journal of Kansas Entomological Society, vol. 12, No. 2, pp. 47-63, April 1939.
497. Statistical Methods Applied to Plant Breeding. Published by title in Proceedings of the Southern Agricultural Worker's Association, New Orleans. February 1939. Texas Station Mimeograph. 23 pp. 1939.
498. Observations on the potato psyllid in Southwest Texas; Janes, M. J. Jour. Econ. Ent. 32(3): 468 (Sci. note) 1939.
499. Behaviour of Certain Characters in Breeding Yellow Bermuda Onions; Leslie R. Hawthorn. Proceedings American Society for Horticultural Science, vol. 36:668-673, 1939.
500. Toxicity of the Coffee Bean (*Sesbania Vesicaria*) for Sheep; I. B. Boughton and W. T. Hardy. Journal of American Veterinary Medical Association, vol. 95, No. 749, Pages 239-241, August 1939.
501. Iodine in City Waters and Vegetables in Texas; G. S. Fraps and J. F. Fudge. Food Research, vol. 4, No. 4, pp. 355-362, 1939.
503. Insecticide Tests for Bollworm Control During 1938; J. C. Gaines. Jour. Econ. Ento., 32(6):821-824, incl., 1939.

506. The Effect of a Pellagra-Producing Diet on Herbivora; P. B. Pearson, H. Schmidt, and A. K. Mackey. *Proceedings of the Society for Experimental Biology and Medicine*, vol. 40, pp. 423-425, 1939.
512. Changes in the Southern Diet Suggested by Food and Nutrition Research; Jessie Whitacre. 1939 *Proceedings of Southern Agricultural Workers Association*, vol. 40, p. 36, February 1939.
514. Possible Cause of Black Kernels in Rice; Alan L. Martin. *Plant Disease Reporter*, vol. 23, No. 5, pp. 83-84, March 15, 1939.
516. Utilization of Energy of Wheat Products by Chickens; G. S. Fraps and E. C. Carlyle, Division of Chemistry. *Jour. Nutrition* 18:385-398, 1939.
518. The Attwater Prairie Chicken—Status, Habits, Requirements, Limiting Factors, and Management; Valgene W. Lehmann. *Transactions, Second North American Wildlife Conference*, pp. 47-55, March 1-4, 1939.
520. Possible Losses of Nitrogen from Acid Soils through the Decomposition of Nitrites; G. S. Fraps and A. J. Sterges, Div. of Chemistry. *Soil Science*, 48:175-181, 1939
526. Inheritance of Horns in Sheep; B. L. Warwick and P. B. Dunkle. *Journal of Heredity*, vol. XXX, No. 8, pp. 325-329, August 1939.
527. The Nicotinic Acid Content of the Blood of Mammalia; P. B. Pearson. *The Journal of Biological Chemistry*, 1939. 129:491-494, 1939.
528. Pasmio Disease of Flax in the Lower Rio Grande Valley of Texas; G. H. Godfrey and Herbert Rich. *The Plant Disease Reporter*, 23: (11):194-195, June 15, 1939.
532. Processing the Fig; H. M. Reed. *Southern Home and Garden*, vol. 7, No. 9, p. 10, (July 1939).

STATION PUBLICATIONS

Bulletin	Title	Author	Number Pages	Number Copies
567	Some Body Measurements of Texas School Children.....	Jessie Whitacre.....	61	6,000
568	An Economic Study of Farm Organization and Operation in the High Plains Cotton Area of Texas.....	B. H. Thibodeaux, C. A. Bonnen, and A. C. Magee.....	75	7,000
569	Comparative Values of Various Protein Feeds for Growing Chicks.....	R. M. Sherwood, and J. R. Couch.....	27	6,000
570	Pasture Improvement in the Gulf Coast Prairie of Texas.....	R. H. Stansel, E. B. Reynolds, and J. H. Jones.....	43	8,000
571	The Utilization of the Energy of Feed by Growing Chickens.....	G. S. Fraley and E. C. Carlyle.....	44	6,000
572	Fertilizer Statistics for Texas.....	G. S. Fraley and T. L. Ogier.....	23	6,000
573	The Control of Cotton Root Rot in the Blackland Region of Texas.....	H. E. Rea.....	36	12,000
574	The Origin of Indian Corn and Its Relatives.....	P. C. Mangelsdorf and R. G. Reeves.....	315	8,000
575	Prickly Pear Eradication and Control.....	W. H. Dameron and H. P. Smith.....	55	6,000
576	Lengthening the Storage Period of Cucumbers.....	Jessie Whitacre, Leslie R. Hawthorn and S. H. Yarnall.....	23	6,000
Circular 82	Control of Tomato Diseases in the Seed Bed and Cold Frame.....	A. L. Harrison, P. A. Young, and G. E. Allsitt.....	14	10,000
83	Abstracts of Bulletins 558-566, Circulars 81-82 and Other Publications During 1938.....	A. D. Jackson.....	45	68,000
84	Suggested Formulas for Special-Purpose Mixed Feeds.....	F. D. Fuller.....	21	12,000
	Fiftieth Annual Report.....	A. B. Conner.....	321	6,000

SUBSTATION NO. 1 BEEVILLE

Substation No. 1, located in Bee County 5 miles east of Beeville, serves the interior Black Prairie Region, a large area of dark colored fertile soils lying in South Texas. Goliad and Victoria soil types predominate in this region. An annual rainfall of 31 inches is fairly well distributed throughout the year, with more of it coming in the winter and spring months. Mild temperatures, with few frosts, prevail; giving an average growing season of 288 days. All these factors combine to make this region admirably adapted to diversified farming with livestock as a base. With the critical period for plant growth coming in the hot and dry seasons in July, August and September, it seems advisable to turn more attention to the growing of crops during the winter and spring months, when normal conditions are more favorable for plant growth. With these facts in mind the station is turning more and more attention to finding and developing crops suitable for growing in the winter months.

The chief concern of this station is the development of a profitable land utilization and soil conservation program adapted to this region. Its activities consist chiefly of testing, developing, growing and curing of feed crops and grasses, and utilizing them through beef cattle; and the testing, developing and growing of profitable cash crops with which to complete a balanced system of agriculture. Some attention is given to the testing of trees and ornamentals for use in landscaping. A recent addition of 300 acres of land and the purchase of much needed equipment have placed the station in much better condition to properly develop this program and to serve, more efficiently, the agricultural interests of this area.

Feed Crops

Climatic conditions were very unfavorable for crop production in 1939. An accumulated rainfall deficiency for the past two years of 16.2 inches, added to a shortage of 13.4 inches in 1939, reduced the available moisture to the extent that practically all crop yields were badly cut. Moisture stored from the 3.44 inches of rain which fell in December 1938, added to light rains in January, February and March, made possible the securing of good stands and fair growth for early planted crops. This moisture was exhausted by midseason and little plant growth was possible during the remainder of the year.

Corn: Good stands of corn were secured and fair growth made in the early season. Moisture was practically exhausted before June 1st and corn was almost a complete failure. Late planted corn was helped some by rains that fell in June. Most of the crop was harvested for ensilage.

Sixty-five varieties and strains were included in the corn variety test. The highest yield of 9.7 bushels per acre came from a hybrid of open pollinated yellow surcropper crossed on a pure lined surcropper strain. All of the higher yields came from the earlier maturing varieties, most of

which had surcrotter blood in them. Late maturing varieties were almost a complete failure because of the moisture deficiency in the later season. In the period of years summary Golden Thomas and White Thomas continue to show best yields of good sound corn.

A corn date of planting test contained 3 varieties planted at 4 dates. The highest yield from each variety came from the April 1st planting with 5.4 bushels per acre from Surcrotter, 2.8 bushels from Thomas and 1.6 bushels from Yellow Dent. The next highest yields came from the Feb. 20 planting. The reserve moisture was responsible for the slight increase in early planting yields while the rains falling during the first week of June was responsible for the slight increase in the late planted corn yields. The period of years summary still indicates that around March 10 is the optimum date of planting corn in this area.

Seventy-two selfed selections of Golden Thomas were interplanted with selected open pollinated ears in an improvement test. Because of the excessive dry weather very poor yields were secured and no constructive results could be recorded.

Grain Sorghums: Grain sorghums continue to supply the major feed crops in all of South Texas. Unfavorable curing weather, weevil damage and high cost of harvesting have been large factors in retarding development of feeding operations based on grain sorghums. These difficulties have been overcome largely by use of trench silos for both forage and threshed grain, and by use of combines in harvesting the grain. Mechanical driers have also played an important part in saving threshed grain. The demand is very great for solutions of problems constantly arising from these new methods of operation. A very unfavorable season retarded the station work on these problems but progress was made on some of the studies.

Thirty-four varieties of grain sorghums and sorgos were grown in a variety test. Most of the varieties were adversely affected by the drouth but fair yields were secured from the first cutting. Most second cuttings gave rather poor yields. The highest yield of grain came from Red Kafir x Hegari, which yielded 35.5 bushels per acre. Red Kafir gave the second highest yield with 34.8 bushels. It was followed in turn by Mazola, Shallu, Red Kafir, Texas Blackhul, Goyza Grass, Quadroon, Hegari and Atlas Sorgo. The highest stover yield came from Goyza Grass with 5.47 tons per acre. Atlas Sorgo came second with 3.9 tons. It was followed by Red Kafir, African Millet, Grohoma, Pink Kafir and Texas Blackhul in the order named.

A period of years summary and general observations indicate that Texas Blackhul and Schrock Kafir are two of the best sorghums for early planting for grain while Hegari is the best for later planting. Atlas Sorgo has made a good showing since it has been grown and is especially adapted as an ensilage crop. Quadroon and Double Dwarf milo are excellent for early planting for quick feed.

Because of dry weather the grain sorghum date of planting test gave low yields on all plats. Hegari made the highest grain yield from March 27 planting with 20 bushels per acre. Its highest forage yield came from April 16 planting with 1.59 tons per acre. Texas Blackhul Kafir gave highest grain yield from March 10 planting and highest forage yield from March 27 planting. Milo grain yield was highest on March 27 planting and its highest forage yield came from May 7 planting. No grain yields were secured from any of the May 7th planting. These results are about in line with a period of years average except that milo usually does better when planted near the first of March.

A rate of seeding test was abandoned because of poor stands.

In a hegari strain test including five strains planted at four different dates the highest grain yields came from the Arizona strain with 23.7 bushels per acre. It was followed in the order named by Early Hegari, Hegari 34911, Hegari 61455 and Hegari 7313, with yields of 23.1, 22.6, 22.0 and 20.0 bushels respectively. All these yields came from the April 1st planting. Hegari 34911 gave the highest forage yield of 3.4 tons per acre. It was followed in the order named by Hegari 61455, Arizona Hegari, Hegari 7313 and Early Hegari. The highest forage yield from each strain came from the March 27 planting except the Early Hegari, which came from April 16 planting. All late plantings were badly injured by drouth.

Quadroon, Sooner Milo and Hegari were grown in a double cropping test in which an effort was made to determine the proper way of handling stalks after first growth was headed, to secure the greatest yield of heads from the second growth. Growth and maturity were so adversely affected by the dry weather that no significant results were obtained.

As part of a state-wide project to study the effect of light and length of day on maturity of sorghums, fourteen varieties of sorghums were planted at four different dates. Poor and irregular growing conditions made it impossible to secure desirable notes on this project.

Small Grain: Forty four wheat, forty four oat and one hundred thirty two spring wheat crosses and selections were planted in a small grain nursery to test their adaptability to this section and their resistance to rust and other small grain diseases. Because of the severe spring drouth very little growth and no yields were secured from any of the plantings. However, some strains showed outstanding ability to make growth under adverse conditions. Slow progress is being made toward the development of a small grain that can be profitably grown in this coastal section. Increased plantings of Victoria Oats yielded five to ten bushels per acre of good heavy oats in the face of the severe drouth. Complete resistance to leaf rust continued to be shown. Weather conditions were unfavorable for stem rust development. Seven acres of Peat land Barley gave good early growth and yielded about seven bushels per acre in spite of the drouth. It was not resistant to stem and leaf rust. Victoria Oats

intertilled with Hubam Clover in eighteen inch rows gave some grazing. This combination is being used more extensively each year by stockmen in this section.

Grasses: Dallis, Rhodes and Angleton grasses planted in 1935 continue to grow and spread under non-grazed conditions. Sods from these grasses were transplanted to an area where they can be grazed. Stands were secured but because of the moisture shortage little growth was made and no grazing was secured. Additional acreage of Rhodes was sown but no germination was secured. Twenty seven sudan strains and crosses were planted in the center of a sudan pasture where they were accessible for free choice grazing of cattle. The cattle showed decided preference for several of the strains. Sudan grass continues to be the most popular cultivated grass for this area.

Cash Crops

Cotton: Cotton continues to be the most popular cash crop in this area. 1939 was a good cotton year in the southern and eastern part of this area where moisture was sufficient, while very poor yields were secured in the northern and western part of the area, because of the shortage of moisture. Station yields were badly cut by the drouth. July rains gave small top crop that added some to the total yields.

Thirty-six varieties and strains were grown in a cotton variety test. The highest yield of seed cotton was produced by Roldo Rowden with 948 pounds per acre. It was followed closely by Delfos 719, with 936 pounds. Wacona came third with 926 pounds. These were followed in the order named by: Mebane, Mebane 804-50-26 x Lankart 11-4, Bagley, Bryant's Mebane and Quick. Late maturing varieties made a better showing than has been recorded for the past few years. In a nine year average Mebane 804-50 continues to lead the field in an average dollar per acre production.

Mebane 804-50 and Lankart, two varieties representing different types of cotton were included in a date of planting test. Beginning on February 20 these varieties were planted at ten-day intervals, up to April 1. The highest yield of Lankart came from March 10th planting with 53 pounds lint per acre. The second highest Lankart yield was 50 pounds from February 20th planting. The lowest yield came from April 1st planting with 38 pounds lint per acre. Mebane produced the highest yield of 51 pounds of lint per acre from the February 20th planting. This was followed in the order named by March 15th, March 1st, March 20th and April 1. A five year average for both varieties gives the highest yield from February 20th planting. This is followed in the order named by: March 1st, March 10th, April 1st and March 20th.

Some hybrids and back crosses of Mebane 804-50 crossed with Lankart were planted. Unfavorable weather caused this test to be abandoned.

However, no progress has yet been made in the effort to combine the desirable characters of these two cottons into one cotton.

Broom Corn: The continued dry weather made broom corn breeding work with Texas Scarborough Dwarf very difficult. Bagged heads on the head to row selections produced poor seed in 1938 and again in 1939. Poor stands and other unfavorable growth conditions made comparison of selections impossible. All selections will be carried into another year. Registered seed production from Texas Scarborough Dwarf was continued. This selection is receiving wide notice in this and other broom corn areas. It is being used largely in this section and is favorably received by the broom corn trade.

In the broom corn spike Inheritance test, seed from good heads, center stem heads, and spike heads were planted again in alternate rows. As in previous years no greater percent of spiked heads were secured from seed coming from spiked heads than from seed coming from good heads. These data continue to indicate that spiking in broom corn is not caused primarily by inheritance but is due largely to environment.

Flax: As a new cash crop for South Texas Flax continues to grow in popularity. From approximately 500 acres in 1938 the crop grew to about 12,000 acres harvested in 1939. This acreage yielded from six bushels under very dry conditions to as high as twenty-six bushels per acre on good land with sufficient rainfall. The crop was successfully marketed at about \$1.50 per bushel. Indications are that 50,000 to 75,000 acres will be planted for 1940 harvest. Most harvesting was done with combines. In some areas where moisture was plentiful a few fields were successfully windrowed with grain reapers and then picked up with combines after drying. The harvest problems are being solved rapidly with the aid of the machinery manufacturers. Flax yields on the station were cut rather short by the severe drouth in the spring. All harvesting was done with a combine without any difficulty.

Eleven varieties were grown in the flax variety test. The highest yield of eight bushels per acre was secured from Boly's Golden. Giza came second with 7 bushels; Rio was third with 6.4 bushels and Bison was fourth with 6.3 bushels. In a four year average Abyssinian Yellow gave the highest yield with 16.6 bushels per acre. Rio ranked second with 16.1 bushels. Rio has some other outstanding characteristics that make it probably the most desirable variety for South Texas.

In a rate and date of seeding test flax was planted at 4 rates: 60 lbs., 45 lbs., 32 lbs., and 18 lbs. of seed per acre. Each of these was planted at seven dates: Oct. 21, Nov. 2, Nov. 21, Dec. 1, Dec. 15, Jan. 1 and February 1. The highest yield of 7.4 bushels per acre came from 32 lbs. seeded on November 21. 6.9 bushels was the second highest yield coming from the same date of planting and 18 lbs. seeding. The 60 pound rate of seeding gave its highest yield from the Nov. 2 planting.

Each of the other three rates of seeding gave the highest yield from the November 21 planting. All rates of seeding gave poor yields from the last two dates of planting. The test was badly injured by dry weather.

In cooperation with the flax division of the United States Department of Agriculture one hundred fifty nine variety and hybrid flax selections were grown in our breeding plats for observation. Dry weather hampered the project but some progress was made in the development of new flax varieties more suitable for winter growing in South Texas. Rio, a new variety of flax seems superior to any commercially available variety for this area. Sixty pounds of Rio seed were secured from United States Department of Agriculture and planted in the fall of 1938. Fair yields were harvested from this planting. Early in May 1939, 500 pounds of this seed was shipped to the State Experiment Station, Aberdeen, Idaho where eleven acres was grown under irrigation during the summer. A yield of 31 bushels per acre was returned to us in late October. Through the cooperation of County Agents this 18,500 pounds of Rio seed was distributed to growers in eleven counties in this area to be increased as certified planting seed.

Castor Beans: Six varieties of Castor Beans planted in an observation test proved almost a complete failure. Because of dry and hot weather all varieties shed their leaves twice during the summer. Following light rains new leaves would appear and a few blossoms would set. Following a fair rain in September new growth was started and a fair crop of seed was set. Most of these were killed by frost on December 28 before the seed were matured.

Fruit Trees and Ornamentals

Because of the severe drouth very few blossoms appeared on any of the citrus trees. All trees continued to live but practically no growth was made during the season. No cold injury was suffered during the year.

Hackberry, Mesquite and Huisache trees continue as leading shade trees for this area. Chinese Tallow trees suffered very severe injury during the extremely hot and dry season.

Tamarix, California and Amur River Privets and senisa, continue to be used largely for hedge and basal plantings. Other native shrubs being used in landscaping are Agarita and Guajilla.

R. A. Hall, E. M. Neal.

Dried Citrus Peel and Pulp in Rotation of Fattening Beef Cattle

The second feeding test for determining the comparative feeding values of ground ear corn and dehydrated citrus peel and pulp in a beef cattle fattening ration, was successfully completed. In the test covering a feeding period of 168 days three lots of 10 steers calves each were used. A ration of Cottonseed meal, ground ear corn and sorghum ensilage was fed

to a check lot. In the second lot 25 per cent of the corn ration was replaced with dried citrus pulp, while the third lot had 60 per cent of the corn replaced with citrus pulp. Although the check lot made somewhat greater gains the two lots receiving citrus pulp showed a slightly higher finish at the end of the test. Results of this test coincide with those of a previous test in indicating that as much as 60 per cent of the grain in a beef cattle fattening ration can be safely replaced with dried citrus peel and pulp. Observations from these tests indicate that the citrus feed is more laxative than the corn and was not particularly palatable in the beginning, but later was readily consumed.

J. M. Jones, R. A. Hall, J. H. Jones, E. M. Neal.

Supplemented Oat Grazing vs. Dry Lot Wintering of Steer Calves

This test covered a 140 day wintering period for feeder steer calves during the 1938-39 feeding season. The results from this one test indicates that oat grazing when supplemented with ground ear corn, and cottonseed meal is superior to grain sorghum silage with the same supplement in a wintering ration for feeder steer calves. The calves receiving the oat grazing made considerably greater gains, were in a more thrifty condition and showed a sleeker coat of hair than the check group fed silage.

J. M. Jones, R. A. Hall, J. H. Jones, E. M. Neal.

SUBSTATION NO. 2, TYLER

Substation No. 2 is located ten miles northwest of Tyler and five miles southeast of Lindale, Smith County, on Highway No. 69; latitude 32 degrees 28 minutes north and longitude 95 degrees 21 minutes west; elevation approximately 504 feet above mean sea level. The average annual rainfall for the past 35 years has been 42.56 inches. The average date of the last killing frost in the spring is March 15, and the first for the fall is November 16. The station farm consists of 455.2 acres of land of which approximately 170 acres are occupied by the East Texas Soil Conservation Experiment Station and operated by the Soil Conservation Service of the United States Department of Agriculture in cooperation with the station. The remaining area is utilized for pasture investigations including the use of dairy cattle, agronomic, horticultural, and plant pathology investigations. At the present time, 40 acres are available for cultivated agronomic and horticultural crops, 150 acres are in cleared pasture, and approximately 95 acres are in woods. In addition, 8 acres are leased for further studies with roses.

The soil is predominantly fine sandy loams of the Kirvin, Bowie, and Nacogdoches series, with smaller areas of other series. The leased land is quite uniformly Norfolk fine sandy loam. The topography is quite rolling, with slopes ranging from three to twenty per cent. There is a difference of 159 feet vertical elevation between the low and high points of the station.

The principal problems of this station deal with (1) conservation, maintenance, and increase of fertility, (2) the production of various agronomic and horticultural crops, (3) the pathological aspects of rose culture, and (4) the production through breeding and selection of better adapted crops.

Agronomic Investigations—Variety Tests

Cotton: The cotton variety test consisted of seventeen varieties. Summerour's Hibred again produced the highest yield of lint—344 pounds per acre, followed by D. & P. L. 12 with 338, D. & P. L. 11-A with 319, Rogers Acala with 309, Watson with 297, and Rhynes Cook with 294. Of the above varieties, only the Hibred and Rhynes Cook have been grown sufficiently long for reliable conclusions. They are both among the high yielding varieties each year.

Corn: The corn variety test included forty-five lots of standard varieties, Texas top crosses, and hybrids from Iowa, Illinois, and Virginia. Yields were better than usual because of more favorable soil moisture conditions. The average yields of commercial varieties, Texas top crosses, and commercial hybrids were 38.0, 41.6, and 39.0 bushels, respectively. The Virginia hybrids were definitely better than the Corn-belt hybrids, but neither sort yielded as well as some of the Texas top crosses.

Soy Beans: Seventeen varieties of soy beans were planted at each of three dates—April 4, May 1, and June 1. No significant differences in yield resulted from the variations in planting rates. Seed yields were practically failures again this year; forage yields were fair. On the basis of seven years results, the Laredo variety may be recommended for forage planting with expected yields approximating those of the higher yielding cow pea varieties, but no variety has been tried that can be recommended for seed production. Planting the Laredo and Mamloxi varieties at rates varying from 20 to 50 pounds per acre did not result in significant yield differences.

Castor Beans: Eight varieties of castor beans were grown to obtain comparative yields of seed. The Kolp selection produced the highest yield, 625 pounds threshed seed per acre, followed by Flowering with 594, Conner with 476, Wagner with 440, U. S. D. A. No. 4 with 355, and U. S. D. A. No. 7 with 352. All of the above are non-shattering types. The Common variety made a relatively fair yield but shattered on maturity. This test was planted on fairly good upland soil, Bowie fine sandy loam, and received an application of 200 pounds per acre of 4-8-4 fertilizer.

Crop Improvement

Texas Seeded Ribbon Cane: The work of selecting an improved strain of Texas Seeded Ribbon Cane has been carried through four inbred generations. It has been possible to discard all except one family, and it was sufficiently increased during the past year to furnish seed for our entire

acreage in 1940. During 1941 seed should be available for limited distribution to growers.

Cow Peas: Two objectives are sought in the cow pea work. First, the production of disease resisting edible sorts, and second, the production of a fine stemmed, disease resisting hay type. The testing of a number of California strains of the Blackeye variety indicates that some of them will at least partially meet the first objective. A strain expected to meet the second objective showed to be too susceptible to nematodes, and further work will be needed.

Cotton: There is a distinct need for a better quality disease resistant cotton in this section. A number of preliminary crosses were made this year with the object of satisfying this need.

Soil Fertility Studies

Cotton and Corn: A test of the relative value of Hairy vetch and oats as green manure crops compared with the commercial fertilizer shown to be best by previous tests indicates, that in a two-year rotation of cotton and corn, the use of Hairy vetch preceding cotton will suffice for both summer crops with yields approximately equal to those from any other treatment. The use of an additional cover crop ahead of the corn has failed to appreciably affect the yields, possibly because of the fact that they do not have time to make significant growth before the date for turning under for the early corn planting.

Dairy Cattle

There has been no noticeable effect of including lime in the grain ration of lactating Jersey cows. Contrary to previous results there likewise were no significant differences attributable to the addition of bone meal to the salt lick of Jersey heifers, daughters of the heifers previously used. Small numbers are represented and no definite conclusions may be reached.

P. R. Johnson.

Rose Investigations

Cultural Experiments: Results of the 1938-39 fertilizer experiments on field roses indicated that greatest response was obtained from applications of nitrogen. Somewhat smaller but definite responses were also obtained from applications of potash, phosphate, magnesium, and calcium. The application of boron and zinc at the rate of 10 pounds per acre resulted in no increase in plant weight. Copper seemed to increase the average weight per plant of rose variety Talisman but resulted in burning of foliage of rose variety Radiance. Bushes receiving no cultivation other than very shallow hoeing for weed control were as good as bushes receiving the regular sweep cultivations throughout the growing season.

Continuing the study of one year plant production by planting cuttings previously budded to a Hybrid Tea variety, it was found that the removal

of the understock top before the Hybrid Tea bud was forced at least 6 or 10 inches resulted in high bud mortality. It was further established that buds should not be closer than 6 to 7 inches on a cane. The partial ringing of the bark by the cuts made for bud insertion resulted in low bud live. With several buds on a cane, those nearest the tip showed the highest mortality. At a 7 and 8 inch spacing either because of some lateral food movement or because of stem twisting and the subsequent twisting of the conducting tissue, buds obtain sufficient food to form a good union.

Understocks: In the past year an additional 250 seeds of the 1937 crosses as well as about 1,250 seeds of the 1938 crosses germinated. About 45 of the plants resulting from the 1937 crosses were selected for testing as understocks. Several of these hybrids seem to have possibilities. Of the 70 understocks tested in the past four years, only one was found to have definite possibilities of replacing the multiflora stock used by most growers in East Texas. That was a *Rosa multiflora* x *blanda* cross developed at Iowa State. It seems to impart exceptional vigor to the Hybrid Tea scions when transplanted from the nursery to the garden. *Rosa caudata* continued to show promising results but was not considered to be as good as the *multiflora-blanda* stock.

Storage and Harvesting: Radiance stored for three months either at 29° or 35° F. survived equally well (92 per cent and 92.7 per cent, respectively) when shipped to and planted at Columbus, Ohio. Pruning bushes before storing to 18 and 24 inches gave the highest live, 95.0 and 97.5 per cent, respectively, when transplanted. Plants waxed with paraffin emulsion previous to storage, while showing a slightly smaller live, 91.7 per cent, than the pruning treatments, seemed to show the highest bloom production per plant—23.4 blooms for wax and 19.4 for the pruning treatments. Talisman stored better at 35°, (91.2 per cent) than at 29° (69.0 per cent) with those plants pruned to 18 inches showing the highest percentage survival after transplanting (96.7 per cent).

Soil Acidification: Soil acidification by use of increments of sulphur promoted increasing growth and bloom production for Radiance and Talisman but not for Joanna Hill. It was found that nitrate depletion following the application of sulphur at rates in excess of 15 to 20 pounds per 100 square feet was very likely due to the use of the nitrate by sulphur oxidizing bacteria.

J. C. Ratsek.

Rose Diseases

Fungicides for Blackspot Disease Control: The 1939 season did not favor severe infection by the fungus causing the leaf disease, blackspot. Infection was sufficient, however, for comparisons to be made between various dust fungicides tested. The results in general indicated the superiority of sulfur-copper mixtures, substantiating previous work by this station. The sulfur mixtures containing the copper compound, Cuproside, gave the best results. Lead arsenate did not appear to im-

prove the fungicidal property of the mixture. With fifteen applications of the sulfur-Cuprocide (10:1) dust, the control of blackspot amounted to 74 per cent and the bushes were 22 per cent heavier than the not-dusted checks. Two brands of ultra fine sulfurs were not as satisfactory as the coarser 325 mesh brands. The copper compounds tested alone without sulfur gave the poorest control of blackspot, but this does not discredit their use as sprays for which they were originally intended.

Experiments to determine the best frequency of application of 325 mesh dusting sulfur for blackspot control gave the following rating from the best to the poorest: (1) weekly after the first symptom of blackspot was observed in the plots; (2) regularly once a week beginning early in the spring; (3) twice a week during the spring and again in the fall; (4) regularly every two weeks beginning early in the spring; (5) weekly when the soil was moist (during or after rain periods); (6) twice a week during the spring only.

The effect on soil pH of twenty-six applications of dusting sulfur (totaling over 500 pounds per acre) applied to rose bushes in the field was determined electrometrically. It increased the acidity at two inches depth from pH 6.1 to 4.9. At six and ten inches deep, the pH was not significantly different from the not-dusted plots (about 5.7 pH).

A test with Mike Sulfur spray (4 pounds: 50 gallons) gave good control of blackspot with variety Edith Nellie Perkins, but resulted in slight burning with varieties Luxembourg and Georges Pernet.

Soaking rose budwood in copper sulfate solution previous to field propagation did not prevent the subsequent development of blackspot although the test was conducted in isolated fields. The method may have been a factor in reducing the primary source of infection, blackspot not having been observed in the test until late in the spring (June 13).

Isolation of Roses as a Means of Avoiding Blackspot: Blackspot free budwood, produced under controlled conditions in a greenhouse and used on the resistant Welch multiflora understocks in an isolated plot, did not inhibit infection. Blackspot was observed April 30 and the nearest source of spores for primary infection was about 550 feet.

Artificial Inoculations with Conidia of the Blackspot Fungus: Tests continued to show the Welch strain of *Rosa multiflora* immune or highly resistant to the disease. However, an upright strain of *R. multiflora* became infected.

Dieback Disease: Dieback did not become prevalent during the 1939 growing season.

Crown Gall Disease: De-eyed cuttings of Welch multiflora soaked in mercuric chloride solution (1:1000 for 30 minutes) before planting showed substantially less crown gall than untreated cuttings as judged from plants at digging time (two year field grown). Cuprocide-talc (1:19)

dust applied to the cuttings also appeared somewhat efficacious. Cuproside 54 (1:400) dip and Hormodin A (10 units, 22 hours) did not reduce infection. Orange shellac may have given partial control but seriously reduced the live of cuttings. In additional tests, treating the cuttings with dusting sulfur allowed excellent live, and Cuproside 54 (1:400—10 minutes) and Semesan (1:400—10 minutes) also appeared favorable; the effect on the occurrence of crown gall remains to be seen.

Cutting off crown galls from rootstocks at the time of transplanting did not give satisfactory control of the disease regardless of whether or not chemical treatments (mercuric chloride and Semesan) were used after the pruning. The fact that in some cases the galls did not reappear indicates that the causal bacteria do not migrate far through the tissue.

Root Knot Control: A rotation experiment is being conducted for the control of root knot disease of roses under field conditions.

Tests to Defoliate Roses: Chemicals were used to artificially remove the leaves and simulate dormancy preparatory to digging. Sulfur dioxide gave complete defoliation and no cane injury following ten minutes fumigation. Of different sprays tried (Elgetol 2 per cent, formalin 14 per cent with spreader, and ammonia 14 per cent with spreader), none was satisfactory.

Watermelon Experiment

Varietal Resistance to Fusarium Wilt: A demonstration test of four varieties planted in an infested field in Wood County gave the following amounts of wilt: Hawkesbury—0 per cent, Klondike R7—0 per cent, Leesburg—11 per cent, and Tom Watson—70 per cent. None of the resistant varieties was considered satisfactory from the standpoint of size, color, and shipping quality.

Eldon W. Lyle.

Soil and Water Conservation Investigations

(In Cooperation with the Soil Conservation Service, U.S.D.A.)

The Tyler station serves an area of approximately thirty-three million acres, twenty-three of which need protection from erosion. The area is rolling to hilly with most of the cultivated slopes ranging from five to eight percent, with some as high as sixteen percent.

The principal soils of the area are Kirvin, Ruston, Bowie, Norfolk, and Nacogdoches, with Kirvin predominating on the station.

Farming is characterized by small farms, irregularly shaped fields; small, simple tools, and the use of large amounts of commercial fertilizer as compared with other agricultural areas of the state. The soils in general are low in fertility, though responding readily to soil-improving practices and proper land treatment.

The most important problem of the area is the conservation of the topsoil and the maintenance of soil fertility. All other problems are hinged on this agricultural resource. The topsoils in general are a sandy loam underlaid with clay subsoils; and as a rule are very erodible, especially during long or intense rains. On the other hand, they bake and crust over during dry periods, resulting in high run-off from rains following a dry period. The conservation of the topsoil is further complicated by erratic distribution and character of rainfall. There are periods of excessive rainfall during which the soil does not absorb all the water that falls, making it necessary to allow some of the rainfall to escape as run-off. These are usually followed by periods of light rainfall, which often occur during the critical crop-producing time. It is believed that the solution of the drought problem must necessarily be arrived at by devising means whereby a greater part, or all, of the rainfall may be stored in the soil so that more moisture will be available for crop growth during droughty periods.

The principal work of the station to date has been the measuring of surface run-off and soil losses in run-off from control plots, terraces, and fields under different conditions. The effects on soil and water losses of such factors as vegetative cover, degree of slope, length of slope, arrangement of crops, crop rotations with winter cover crops, and terracing, including grade, spacing, and length, are being studied.

Over a period of years, a number of studies have shown sufficiently definite trends to warrant their terminations. Others have not yielded conclusive data, but have given indications which are being used to point the way in setting up new studies. There are many problems which will require continued study before it is possible to arrive at definite conclusions. There follows a brief review of some of the more important problems under study.

Control Plots

The information obtained from control plots is comparative for different agricultural practices and treatments. The results obtained serve as indicators in the development of erosion-control methods. In addition, information is obtained which relates to the fundamentals underlying the causes and effects of erosion.

Some of the indications to date are as follows:

1. **The effect of slope characteristics.** The results have shown a definite increase in soil loss with an increase of slope grade and slope length. An increase in slope length has not shown any material increase in percentage of water loss as run-off.

2. **The effect of plant cover.** The results show quite conclusively that Bermuda grass sod and native forest cover, for all practical purposes, prevent soil and water losses. The problem is not solved because all

land cannot be planted to grass and trees. A crop rotation including cowpeas, cotton, and sorghum with a winter cover crop of vetch aided greatly in the reduction of both soil and water losses when compared with continuous cotton. Additional investigations in the use of cover crops for erosion control and soil improvement were initiated in 1939.

3. **The effect of exposed subsoil.** Subsoil plots receiving the same treatment as their respective normal topsoil plots over a period of years have proved to be, in round numbers, three times more erodible. Such areas would probably be best utilized by planting to grass or trees.

4. **The effect of soft fallow.** Soft fallow in comparison with continuous cotton has shown an increase in percentage of rainfall lost as run-off from the fallow plot. It follows that the practice of fallowing in this area is not to be advocated in a well-rounded agricultural program.

5. **The effect of burning wooded areas.** The results over a period of years have shown that the practice increases both soil and water losses. These losses have increased from year to year. During 1939, there were twenty storm periods which produced run-off on the burned plot. This is the first year that no run-off has occurred on the unburned plot. The practice of burning wooded areas not only increases run-off and soil losses and often destroys young trees, but also destroys the habitat of valuable wild game.

6. **The effect of crop rotation with a winter cover crop of vetch.** A three-year rotation of cowpeas, cotton, and sorghum with a winter cover and green manure crop of vetch in comparison with a check of continuous cotton is used in this study. The rotation has shown a marked decrease in soil loss per acre. During the past season, the rotation plots lost an average of 11.8 tons of soil per acre; whereas, the two check plots of continuous cotton without a winter cover crop lost an average of 18.6 tons of soil per acre, a difference of 6.8 tons of soil per acre in favor of the rotation and winter cover crop of vetch.

Terrace and Watershed Studies

1. **Terrace grade.** The results from the terrace grade studies have shown that soil and water losses decrease as the terrace grade decreases.

2. **Terrace spacing.** From data secured from terraces included in this study, there is no conclusive evidence indicating a well-defined optimum terrace spacing.

3. **Terrace length.** Results to date indicate that the losses from different length terraces will be within narrow limits and that the control of terrace outlets should be the determining factor in the design of a terracing system rather than the length of the individual terraces.

4. **Terraces with strip crops.** This study consists of terraces with one-third of their areas in an erosion-resistant strip crop of either sorghum or oats. The strips are located in three positions: immediately above

the terrace channel, mid-interval, and the back side of the terrace, beginning with the top of the terrace ridge. To date, the strip located immediately above the terrace channel has given the minimum soil and water losses.

5. **Comparison of soil and water losses from terraced and unterraced areas.** The soil losses on the unterraced area have been much greater than on the terraced area. The terraced area is in a much more satisfactory farming condition than it was when the terraces were constructed; whereas, the unterraced area is badly gullied, and it is only a question of time until its present treatment will have to be revised or the field will reach a stage making it necessary to be abandoned.

During the year 1939, all of the terraces under measurement revealed marked decreases in soil losses over the year 1938 and also a decrease in the soil loss per cubic foot of run-off. This decrease in soil loss ranged from thirty-eight to forty-eight percent. In contrast to this, the unterraced cultivated watershed indicated an increased soil loss of over sixty percent and, likewise, an increased soil loss per cubic foot of run-off.

6. **Watersheds of different characteristics.** This study consists of three watersheds, two of which are being cultivated and the other is a wooded area. One of the cultivated watersheds is strip cropped and the other is without any control measure other than being cultivated on the approximate contour. Data from these areas are being prepared in graphic form for the Watershed and Hydrologic Section in connection with the preparation of flood control data.

It is significant that for the year 1939 both of the cultivated watersheds had increased soil loss and significant increases in the soil loss per cubic foot of surface run-off over the year 1938, while the wooded watershed had noted decreases in both instances. The increased soil losses were more than sixty percent from the cultivated areas, while the decrease in the soil loss from the wooded watershed was approximately eighty percent.

J. B. Pope, O. C. Word, J. C. Archer.

SUBSTATION NO. 3, ANGLETON

Substation No. 3 is located 3.1 miles northeast of Angleton, Brazoria County, adjacent to the St. L., B. & M. Railroad. The latitude is 29 degrees north and the longitude 95 degrees west with an elevation of 23 feet above sea level. The Station is located in the Gulf Coast Prairie region and the soils are of the Lake Charles and Edna series. The topography is flat with slow drainage. The average annual rainfall over a period of 26 years was 45.58 inches as compared with 43.84 for 1939. The maximum temperature for a period of 26 years was 105 degrees F. and the minimum temperature for the same period of time was as 10 degrees F., as compared with 104 degrees and 27 degrees, respectively, for 1939. The average relative hu-

midity for a period of 24 years was 79.7 per cent and the average annual evaporation for the same period of time was 44.738 inches. The average date of first killing frost in the fall is December 1 and of the last killing frost in the spring is February 28, giving an average growing season of 276 days.

The growing season of 1939 was characterized by a dry spring, a heavy summer rainfall, and a dry fall. July had 15.50 inches of rainfall, 15.42 inches of which occurred in three days. The heavy summer rainfall was injurious to the cotton crop although an average corn and cotton crop was produced. Pastures were short the last of the year due to a lack of rain. Schrock Kafir produced above average yields of grain.

Field Crops

Cotton: Twenty one varieties were grown in the cotton variety test in 1939. The July rains caused all squares and all bolls not over half grown to shed, resulting in an average yield where the crop appeared very promising before the rain. D & P L 11A made the highest average yield with 400 pounds of lint cotton per acre followed in order by Hi-Bred, D & P L 12, Stoneville 2B, Mebane 804-36 and Stoneville 5A with 395 pounds, 384 pounds, 366 pounds, 342 pounds and 340 pounds of lint cotton. Of the varieties that have been tested continuously for the past five years, D & P L 11 and 11A has made the highest average yield with 433 pounds of lint cotton per acre, followed by Stoneville 5 and 5A, Rogers Acala, Mebane 804-50, New Boykin and Oklahoma Triumph with 376 pounds, 373 pounds, 369 pounds, 350 pounds and 349 pounds per acre respectively. D & P L 11A is being widely grown in the Gulf Coast region and is proving very popular. D & P L 11A and Rogers Acala are the varieties being used almost exclusively in the one variety communities of this region. Both are varieties producing an excellent quality of lint.

The inbreeding work with Mebane 804 was continued in 1939. Statistical information on the effect of inbreeding as compared with straight plant selection on the uniformity and yield of cotton is the object of this test, together with the length of time required to reach any degree of uniformity, as compared with the original parent material. A number of promising plant selections have been obtained in this test and they are being grown in replicated plats with Mebane 804-36, the highest yielding strain obtained to date from the parent strain, Mebane 804.

Corn: In the corn variety test 19 varieties, 7 commercial hybrids, 15 Yellow Surcopper top crosses, 12 Yellow Tuxpan top crosses and 1 commercial hybrid planted doubly thick were grown in four replications. The weather conditions were more favorable for the early varieties than for the late varieties this year. Of the varieties grown, Red June made the highest average yield with 36.1 bushels of shelled corn per acre, followed in order by Golden June, Reese Drouth Resistor, Mexican June, Jellicorse and Yellow Surcopper with 34.2 bushels, 33.4 bushels, 32.9 bushels, 31.4

bushels and 31.1 bushels per acre respectively. Of the commercial hybrids, Wood 2257 produced 37.9 bushels per acre, Pioneer 307 produced 35.4 bushels per acre while the others produced from 27.9 to 24.0 bushels per acre. Pioneer 307 was also planted doubly thick but the thick planting produced a lower yield than the regular planting rate. Several of the Yellow Tuxpan top crosses produced a higher yield than Yellow Tuxpan but the differences were not significant. Several of the Surcropper top crosses produced significantly higher yields than Yellow Surcropper, the highest top cross yield being 40.2 bushels as compared with 31.1 bushels for Yellow Surcropper.

Of the varieties tested for a number of years, White June, Red June, Golden June, White Surcropper and Yellow Surcropper are recommended as early varieties for this section and Yellow Tuxpan and White Tuxpan as the best late-maturing varieties.

The same type of corn breeding work with Yellow Tuxpan as started in 1937 was continued this year. Of 500 selfed ears of Yellow Tuxpan, 36 are selected for type and are grown in replicated ear rows, detasseled and pollinated by massed rows of selected open pollinated ears. The ears producing the highest yield and best type are grown in the variety test for further yield data. To date none of the ears have proven to be significantly higher in yield than the massed Yellow Tuxpan but the type has been greatly improved by this method of breeding.

Work with a Yellow Sweet Tuxpan, a Red Cob Yellow Tuxpan and a strain of yellow corn combining characters of Yellow Tuxpan and Yellow Surcropper was continued in 1939.

Schrock Kafir for Grain Schrock Kafir is the outstanding variety of grain sorghum at this Station. In a comparison of Schrock Kafir and Yellow Tuxpan corn for grain yield in 1939 Schrock Kafir produced 44.1 bushels per acre as compared with 17.9 bushels for corn. In an eleven year average Schrock has produced 24.6 bushels per acre as compared with 17.5 for Tuxpan corn. Schrock Kafir has a high tannin content and the tight glumes make it resistant to bird damage. The loose heads prevent much mold and head worm damage in this region. Schrock Kafir can be planted until August 1st and make a good seed crop.

Forage Yields of Corn, Sunflower and Sorghum Varieties: Amber made the highest yield of air-dry forage in 1939 with 7.78 tons per acre followed in order by Orange, Red Top, Hegari and Schrock Kafir with 7.08 tons, 6.52 tons, 5.24 tons and 5.04 tons per acre respectively. Hegari and Schrock Kafir had much poorer stands than the other varieties. Mammoth Russian Sunflower produced 2.57 tons per acre and Tuxpan corn produced 2.42 tons per acre. For the past six years Orange has made the highest average yield with 4.68 tons of air-dry forage per acre followed by Schrock Kafir with 4.16 tons, Red Top with 3.98 tons, Amber with 3.86 tons, Hegari with 3.32 tons and Tuxpan corn with 1.63 tons. Orange,

Schrock Kafir and Red Top are the highest yielders of forage in this section. Since Orange produces three cuttings many years, Schrock Kafir or Red Top may be preferred since they produce only two cuttings. Schrock Kafir produces more grain than any of the other sorghums and may be preferred for that reason.

Wheat Rust Nursery: The dry spring weather greatly reduced the growth of the wheat strains. Leaf rust was severe on the susceptible varieties and Stem rust occurred on some varieties. The rust resistant strains produced by the Texas Experiment Station showed very little rust and many showed no rust infection. The susceptible commercial varieties produced from nothing to 2.9 bushels of grain per acre while the resistant Texas strains produced from 8.4 bushels to 18.8 bushels of grain per acre. Many of these strains are very promising.

Oats Rust Nursery: The Texas rust resistant oat strains showed very little rust this year as compared to the susceptible commercial varieties, but rust appeared too late to greatly affect the grain yield of any of the varieties. A shower after the oats headed provided sufficient moisture to allow the heads to fill but lack of moisture in the spring reduced all yields. The yields ranged from 36.8 bushels to 64.2 bushels per acre with most strains producing from 45 to 55 bushels per acre as compared with 44.2 bushels for Nortex and 44.8 bushels for Country Common.

Flax: Ten varieties of flax were grown in a variety test this year. Giza produced the highest average yield with 13.3 bushels per acre followed in order by Rio with 12.6 bushels, N. D. 114 with 12.1 bushels and Bolley's Golden with 12.0 bushels. Bison produced 10.6 bushels this year. Of the varieties grown each year for the past four years Linota has averaged 9.3 bushels per acre, Bison and Bolley's Golden have each averaged 8.8 bushels, Abyssinian Yellow has averaged 7.1 bushels and Punjab has averaged 5.2 bushels.

Soy Beans: Seventeen varieties of soy beans were grown in a variety and date of seeding test. The plantings were made on April 19, May 3 and May 25 and the growth and stands were good. There was no consistent differences in seed yield for the early, medium or late plantings. The highest seed yield was produced by Charlee with 556 pounds at the medium planting date. Other varieties ranged from no seed matured up to 382 pounds per acre. The seed produced was of poor quality. No profitable yields or good quality seed has been produced during the past four years at this Station.

The early and medium plantings made a higher yield of forage than the late plantings on most varieties. The highest average yield for the three dates of planting was made by Laredo with 1.56 tons of air-dry forage per acre followed by Charlee with 1.32 tons and Ootootan with 1.31 tons. During the past four years the early planting has produced the highest yield. Laredo has produced the highest yield with 1.55 tons of

air-dry forage per acre during the last four years at the early planting date followed by Ootootan with 1.34 tons, Delnoshat with 1.30 tons and Avoyelles with 1.27 tons.

In an inoculation and rate of seeding test with Mamredo soy beans inoculation has had very little effect on the seed or forage yields. The planting rates of 20, 30, 40 and 50 pounds per acre produced no consistent differences in seed or forage yields, although the 20 pound seeding rate produced slightly lower yields. These results are in accord with results obtained for the past four years.

Castor Beans: A test of 5 varieties of castor beans was conducted in 1939. The seed yields were not complete at the end of the year since many green pods still remained on the stalks. Of the seed yields obtained to the first of the year USDA No. 4 made the highest yield with 755 pounds of clean seed per acre followed by Flowering with 727 pounds, USDA No. 7 with 691 pounds, Common with 237 pounds and Brazilian with 129 pounds. USDA No. 4 ripened evenly but the Flowering variety had large seed, ripens evenly, shatters very little and appears most promising.

Winter Legumes: Four varieties of winter legumes were grown on bedded and flat land and with and without 40 pounds of phosphoric acid per acre. Bedding the land increased the yield of Hubam and Alsike clovers but reduced the yield of Yellow Annual Sweet clover and Hairy vetch. The phosphoric acid fertilizer increased the yields of Yellow Annual Sweet, Hubam and Alsike clovers but had no effect on the Hairy vetch yield. This is the first year of this test.

Fenugreek was planted on prepared land and also seeded on sod pasture. The growth was poor in all cases, and the yields about half that of Hairy vetch or Yellow Annual Sweet clover. Station livestock failed to graze on the Fenugreek in the pastures.

Fertilizers: The fertilizer test with corn and cotton was continued this year as in previous years. Using a 4-12-4 mixture at 400 pounds per acre as a basis, each fertilizing element was varied independently. Several 800 pound applications were used and the 4-12-4 mixture was applied at rates of from 200 to 1,000 pound applications. Nitrogen and phosphoric acid are the chief needs of the Lake Charles soils of this section. In 1939 the no treatment plats averaged 256 pounds of lint cotton per acre as compared with 318 pounds of lint for the 400 pound application of 4-12-4 fertilizer, 379 pounds of lint for the 400 pound application of 8-12-4 fertilizer and 485 pounds of lint for the 800 pound application of 8-12-8 fertilizer. Potash has been of little value in this test.

The dry spring and heavy summer rain reduced the yield of corn in this test and no profitable increases in yield were obtained. The yields for the various treatments varied from 15.5 bushels to 22.2 bushels. Nitro-

gen has proven to be more valuable for corn than for cotton during the past nine years of this test.

In a test using large amounts of potash under cotton, potash gave some increase in yield in 1939. The check plats receiving 400 pounds of 4-12-4 fertilizer averaged 356 pounds of lint per acre as compared with 441 pounds of lint where 250 pounds of muriate of potash was used in addition to the same amount of 4-12-4 as used in the check plats and as compared with 477 pounds lint where 500 pounds of muriate of potash was used in addition to the 4-12-4. During the seven years of this test the average yields have been 429 pounds, 426 and 465 pounds of lint cotton per acre respectively for these treatments. The use of the additional amount of potash has not been profitable.

A pasture fertilizer test on a carpet grass sod has been carried for the past four years. The fertilizers have been applied to the surface of the sod in the early spring each year. In 1939 the no treatment plats averaged 2,652 pounds of air-dry clippings per acre as compared with 3,666 pounds per acre for the 0-40-0 fertilizer, 3,834 pounds per acre for the 40-40-0 fertilizer and 4,685 pounds per acre for the 40-80-0 fertilizer. These fertilizer formulas represent the pounds of available fertilizer per acre. During the four years of the test the above treatments averaged 2,760 pounds, 3,082 pounds, 3,447 pounds and 3,750 pounds of air-dry clippings per acre respectively. These increases have not been profitable.

Time and Method of Seedbed Preparation Test: This project was started in 1932 and the land is prepared in the fall or spring or both and either bedded or flat broken or both. All combinations of these methods of preparation are used and corn and cotton are grown in a three year rotation of two years cotton and one year corn. The fall preparation is made as soon as the crops are harvested and soil conditions will permit and the spring preparation is made as soon after February 1 as soil conditions will permit. Fall flat breaking produced the highest yield in 1939 with 420 pounds of lint cotton per acre followed by spring flat breaking with 341 pounds, spring bedding with 319 pounds and fall flat breaking with spring bedding with 300 pounds. The lowest yield was made by fall bedding with 268 pounds of lint per acre. During the seven years of the test fall bedding with spring rebedding, fall flat breaking, spring flat breaking, spring bedding and fall flat breaking with spring bedding made average yields of from 373 to 363 pounds of lint cotton per acre, the difference not being significant, although there was a considerable variation in yields from year to year. Fall flat breaking with spring flat breaking produced 344 pounds of lint cotton per acre and fall bedding produced 341 pounds of lint cotton per acre. Method of preparation is not as important with cotton as is thorough preparation, regardless of method. The results with corn are similar to those of cotton, the differences in yield being less than four bushels per acre which are probably not significant.

Cotton Green Manure Test: A cotton green-manure test was started in 1937 using Yellow Annual Sweet clover as a winter green-manure crop and using a 4-8-4 fertilizer of which two-thirds of the phosphoric acid was applied in the fall on some plats and all of which was applied in the spring on other plats. The object is to determine the effect of the fall fractional application of the phosphoric acid on the clover growth and to determine their combined effect on the succeeding cotton crop. The fall application of part of the superphosphate has failed to increase the growth of the clover. The clover growth has been very poor each year of the test although the stands have been good.

Rotation Studies: Corn, cotton, Schrock Kafir and cowpeas have been grown in various rotations, with and without winter legumes and with and without fertilizers. The use of a winter legume in corn, cotton and Schrock Kafir rotations has resulted in increased yields. Where cowpeas were used in the rotations one year and harvested for hay the yields of the other crops were increased more than from the use of the winter legume. The winter legume used was Yellow Annual Sweet clover which made a poor growth and had to be turned under early in the season in order to get the other crops planted sufficiently early to make a normal yield.

R. H. Stansel.

Horticultural Work

Grapes: The vines in the grape variety test did not appear to be as vigorous this year as in previous years and the yields were low. Lomanto produced the highest yield with 3546 pounds per acre, followed by Black Spanish, Armalaga, Champanel, and Chasselas de Fountainebleau in the order named. The total soluble solids of the juice were about the same this year as last and the acid content was much lower with the exception of that of the Lomanto juice which was slightly higher.

Strawberries: Eight strains of strawberries produced by the Winterhaven Station which were planted at the Angleton Station in 1937 were again compared with the standard varieties, Missionary and Klondike. Ranger made the highest yield with 6516 pounds per acre, followed by Texas 54 with 5653 pounds; Texas 26, 4811 pounds; Alamo, 3519 pounds; Texas 22, 3064 pounds; Texas 15, 2925 pounds; Missionary, 1598 pounds; Klondike, 1514 pounds; Texas 65, 751 pounds; and Texas 56, 714 pounds. A new planting was made in 1938 which included the following strains which had not been previously tested at this station: Texas 34, Texas 45, Texas 28, Texas 19, Texas 29, and Texas 10. The new test did not become well established this year because of dry weather after the plants were set out and the yields were much lower than with the old test. The acre yield of the first five highest producers in the new test as compared to Missionary and Klondike were as follows: Texas 34, 1822 pounds; Texas 45, 1376 pounds; Texas 28, 1286 pounds; Texas 26, 1202 pounds; Alamo, 1190 pounds; Missionary 1021 pounds and Klondike 719 pounds.

The quality of the strawberries was not as good this year as last because of unfavorable weather conditions.

Other Fruit and Nut Variety Tests: No yield data were recorded this year on peaches and pears. An extremely light crop was obtained on the plums, the highest yield being on the Excelsior variety with an average of 7.5 pounds per tree. Only a few Satsuma oranges were produced and the yield of Meyers lemon averaged 23 pounds per tree as compared with 49 pounds last year. The low yields are probably due to the freeze of the previous year which injured the trees. Three varieties of berries set fruit with the following per acre yields: Advance 687 pounds; Selection No. 2, 73 pounds, and Lawton 48 pounds. The pecans produced only a few nuts this year. Mayhan produced the most nuts but these were of poor quality and Schley had the best quality nuts.

H. M. Reed and R. H. Stansel.

Fig Breeding Work

The following fig crosses were made in 1939: Gentile, Negro Largo, Figure D'Or, and Violette de la Frette x Hamma, Gentile and Negro Largo x A Boise Jaspee, and Magnolia x Ficus carica. Seeds were obtained from these crosses which will be planted this year. Seeds were obtained from the cross Ficus Nota x Hamma from the U.S.D.A. in Florida. The Hamma pollen for the cross was furnished by this station. Twenty-four seedlings from crosses which were made in previous years produced edible fruit which was described. Most of this fruit was produced on the Magnolia x Hamma cross and so far none has been found which seems to be particularly outstanding. None of the seedlings have produced capri figs thus far.

Many of the capri fig varieties in the variety orchard produce fruit which drops from the tree before it reaches maturity. Tests were made by injecting a number of different reagents into figs of some of these varieties to see if they could be made to "stick" and reach maturity. In a few cases a 0.01 per cent solution of alpha-naphthalene acetic acid and a suspension of pollen in water accomplished this result.

Tests with fig pollen indicated that the viability could be prolonged from about 5 days when held at ordinary room temperature to over 2 months when the pollen was held at 50° F. It was important that the pollen be placed at the lower temperature within one day after being gathered.

H. M. Reed and S. H. Yarnell.

Fig Products Investigations

Figs in the variety orchard first started to set fruit on February 18 and continued to set fruit until October 14. About 65 varieties produced mature fruit which was described and on most of which processing tests were made.

A comparative freezing storage test was made between Magnolia and Green Ischia figs. The Magnolia pack was slightly better than Green Ischia although there was some indication that the latter variety would have been better if a heavier sirup had been used than with the Magnolia. After approximately a year of storage the red pulp color of the Green Ischia variety had faded somewhat.

Bourjassotte, De L'Archipel, A Boise Jaspee, Hamma, and Gentile gave lye peeled preserves which were as good as the Magnolia preserves. The texture of De L'Archipel and the appearance of Gentile were outstanding. The greatest difference between lye peeled and unpeeled preserves was in the poorer appearance of the unpeeled preserves, although in some cases the flavor seemed to be slightly improved when the fruit was not lye peeled. Unpeeled preserves which were outstanding in flavor were Negro Largo, Precoco de Barcelona and Green Ischia. Of the 42 varieties tested in the light sirup pack De La Madeline, Bianco Grosso, and Smyrna x Maslin capri were better than Magnolia, while Cordelia and Abois Jaspee were as good. Pauly's No. 2 was outstanding in appearance, Smyrna x Maslin capri and La Madeline in texture, and Reculver, D'Agen and Hative de Argenteuil in flavor. Examination and suggestions made by this station resulted in an improvement of the commercial 1939 light sirup pack over that of the 1938 pack. The improvement was brought about by reduction of sirup cut out density, greater care in the selection of properly matured fruit, size grading, and more uniform packing in the container.

H. M. Reed.

Grape Juice Blending Experiments

A preliminary consumer test of eleven samples made up by blending various proportions of a comparatively low acid, high total soluble solid juice with a comparatively high acid, low soluble solid juice showed that the preference was for a tart juice and one in which the purple color was predominant. In the grape juice tests 11 straight juices and 19 blended juices were prepared from 13 varieties of grapes. Judging of the samples was done by two independent groups and conclusions were drawn from the two groups as a whole. A well known commercial brand of Concord grape juice was compared with the Texas juices. On a basis of average quality rating which took both appearance and taste into consideration, the following four Texas juices were better than the commercial juice: America (100 per cent); 25 per cent Carman plus 75 per cent Virginia; 25 per cent Virginia plus 25 per cent Carman plus 25 per cent Fern Munson plus 25 per cent America; 75 per cent Virginia plus 25 per cent Catawba. The straight American juice was considered outstanding in quality. Three of the blends were considered as good as the commercial juice. These were: 50 per cent Carman plus 50 per cent Virginia; 50 per cent Black Spanish plus 25 per cent Delaware plus 25 per cent Catawba; and 75 per cent Carman plus 15 per cent Virginia plus

10 per cent Mustang. The proportions of the above blends were based on the per cent by volume. Two of the above named blends used Carman and Virginia alone, the two varieties of which there is the largest available amounts, and 6 other varieties including America, Fern Munson, Catawba, Black Spanish, Delaware, and Mustang were used in these blends.

H. M. Reed and U. A. Randolph.

SUBSTATION NO. 4, BEAUMONT

Substation No. 4 is located six miles west of Beaumont on the Houston road at latitude 30 degrees north, and longitude 94 degrees west. The elevation is 26 to 30 feet above sea level. The station comprises 100 acres of land consisting largely of Lake Charles and Crowley clays. These are typical rice soils of this region. The total rainfall during 1939 was 35.95 inches as compared to a normal of 52.41. The precipitation was noticeably below the average during the months of March, April, May, June, September, and October. The temperature dropped to freezing on but 9 days during the year as compared to a normal of 14.1. There were no late freezes in the spring or any early ones in the fall.

Rice Investigations

(In cooperation with the Division of Cereal Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture.)

Rice Fertilizer Test: The results obtained in the large field plats show consistent increases in yield from the use of sulphate of ammonia. The use of 50 pounds of sulphate of ammonia per acre increased the yield 265 pounds per acre, and as the amount of fertilizer was increased the yields became larger with an increase of 739 pounds being obtained from the use of 200 pounds of this fertilizer. Superphosphate alone did not produce any increase in yield, but was of slight value when used in combination with sulphate of ammonia.

Sources of Nitrogen and Phosphorus: Regular and granular sulphate of ammonia, cyanamid, uramon, and nitrate of soda were used at rates to furnish 20 pounds of nitrogen per acre. The granular form of sulphate of ammonia increased the yield 19.33 per cent. The other materials produced increases of 9.96 to 13.58 per cent. Regular and granular superphosphate, calphos, and bone meal were used at rates to supply 20 pounds per acre of phosphoric acid. Bone meal increased the yield 28.37 per cent as compared to increases of 9.96 to 17.50 per cent for the other materials. As phosphoric acid alone has failed to produce increases in yields, regular sulphate of ammonia at the rate of 20 pounds of nitrogen per acre was used with each fertilizer furnishing phosphorus. A uniform treatment of granular superphosphate, 20 pounds of phosphoric acid per acre, was used with each nitrogen bearing material.

Methods of Applying Fertilizer to Rice: Superphosphate alone did not increase the yield when applied either on top of the soil or in the drill with the seed. Sulphate of ammonia at the rate of 150 pounds per acre increased the yield 13.10 per cent when applied on top of the soil, and 22.93 per cent when placed in the drill with the seed. Superphosphate was of no value in combination with sulphate of ammonia when applied on top of the soil, but increased the yield 27.36 per cent when this treatment was drilled in with the seed. This 27.36 per cent increase amounted to 592 pounds per acre more than on the untreated plats.

Cooperative Rice Fertilizer Tests: Cooperative tests were conducted in Orange County, on a farm near Nome, and at this station. These tests included five fertilizer treatments and a no treatment, and each location was on a different type of soil. In all cases the yields were increased by the use of fertilizers, but the smallest increases were obtained on the farm near Nome. Also, in each test a combination of nitrogen and phosphoric acid produced larger increases than either when used alone. The use of 100 pounds of sulphate of ammonia in combination with 200 pounds of superphosphate increased the yield 14.41 per cent at Nome, 47.03 per cent at this station, and 62.0 per cent in Orange County. The addition of potash appeared to be of slight value in Orange County and in the test at this station, but of no value at Nome.

Cylinder Experiments with Fertilizers on Rice: The cylinders used for the seventh consecutive year contain Lake Charles clay soil. The yields have been decreasing each year with the 1939 yields being the lowest. The use of superphosphate or sulphate of ammonia alone increased the yields of both straw and grain, but superphosphate was noticeably superior to sulphate of ammonia. Also, in each case the yield of straw showed a larger increase than the grain. In addition, the lighter rates of either superphosphate or sulphate of ammonia produced larger increases than the heavier applications. This was not true during the first few years. While both superphosphate and sulphate of ammonia increased the yields of grain and straw, a combination of the two was not any better than the former alone.

In cylinders used for the sixth year in comparing sulphate of ammonia and ammoniated peat as sources of nitrogen, the latter failed to produce any increase in yield, but the sulphate of ammonia increased the grain yield 17.89 per cent. Superphosphate was slightly superior to bone meal as a source of phosphoric acid with an increase in grain of 43.42 per cent as compared to 36.58 per cent. All straw yields were increased by the use of these fertilizers, but the increases were noticeably smaller than with the grain.

Sulphur on Rice Soils in Cylinders: This is a study on the tolerance of rice plants to various degrees of acidity and alkalinity. The soil in these cylinders was treated with sulphur and lime in 1937 to get pH's from 4 to 8. Readings taken before planting in the spring of 1939 showed

that the pH of the soil receiving the heavy sulphur treatments was around 4.5 to 4.7, and that of the soil limed heavily was around 7.3. Shortly after the irrigation water was applied there was a noticeable rise in the pH of the soils showing low readings at the first of the season, and a lowering of those that were high at the earlier date. However, after the soil was drained in the fall there was noticed tendency for the readings to be as they were before the water was applied. The largest yields of both straw and grain were obtained from the cylinders showing the lowest pH readings. The use of fertilizers failed to increase the yields. The plants grown in soil of the higher pH readings were severely attacked by the sugar cane borers, and showed a rather severe infection of stem rot.

Rice Rate of Seeding: Rice seeded at the rate of 60 pounds of seed per acre without fertilizer produced a yield of 1,900 pounds per acre. The yield was increased as the rate of seeding increased. However, the increase was very small with the heaviest rate of 140 pounds of seed producing only 2,050 pounds of grain per acre. A similar test receiving 600 pounds per acre of an 8-8-0 fertilizer produced larger yields, but the heaviest yield was from the lightest rate of seeding. The yields decreased as the rate of seeding increased. The 60 pound seeding rate produced 3,150 pounds of grain per acre as compared to 2,794 pounds for the 140 pound rate.

Rice Rotations: This test includes eight different two-year rotations. The 1939 yields were very low with one exception. The yield from the plat that is left idle when not cropped to rice was 2,262 pounds per acre. The second highest yield of 1,688 pounds was obtained from the plat that is summer fallowed during the time it is not in rice. All other rotations produced noticeably lower yields. Also, much difficulty was encountered in trying to keep the plats grown to row crops free of weeds.

Rice Variety and Date of Seeding: This test included fifteen varieties planted at 20-day intervals from March 20 to June 10, inclusive. Early maturing varieties producing their largest yields when planted about April 30 to May 20. The later maturing varieties produced their heaviest yields when planted from March 20 to April 10. Blue Rose, T. S. No. 7183 produced the heaviest yield obtained in the test this year. Lady Wright produced the smallest yield. The later maturing varieties produced noticeably larger yields than the early maturing ones. The average yields at each date show the March 20 planting to be slightly larger than the ones made at the other dates. However, there is very little difference in the averages from the different dates of seeding.

R. H. Wyche.

Field Crop Investigations

Cotton Varieties: Cliett produced only 174 pounds of lint per acre this season. All of the other twenty-two varieties produced 200 or more pounds per acre with Hi-Bred producing the heaviest yield of 294 pounds followed by Delfos 531 B with 291 pounds. The blooming and picking periods were

shorter than usual this season. This was probably caused by the lack of moisture during the latter part of the growing season. With five exceptions, 90 per cent or more of the cotton produced by each variety had been harvested at the end of 129 days after the plants had emerged. Practically the entire crop was harvested at the end of 141 days.

Corn Varieties: The thirty-one varieties tested in 1939 produced an average yield of 16.7 bushels per acre. The three largest yields of 26.5, 25.9, and 25.0 bushels were produced by three hybrids, Y. S. X 155A, Y. S. X 127C, and Wood 2257, respectively. Twenty-one varieties produced less than 20 bushels per acre, and five produced less than 15. Florident White produced the lightest yield of 9.3 bushels per acre.

Perilla and Chia: Small plantings of these two crops were made again in 1939, but the growth was very poor. The poor growth and thin stands were attributed to lack of rain during the early growth of the plants. Seed yields were not sufficient to justify taking records on yields with either crop.

Castor Beans: Six varieties of castor beans were planted in 1939. The growth was probably not normal due to insufficient moisture during the larger part of the season. A more detailed report on this planting will be found under the report of the Division of Agronomy.

R. H. Wyche.

Forage and Pasture Crop Investigations

Pasture Fertilization: All fertilizer treatments, including liming, increased the yields of forage. The use of phosphoric acid produced larger increases than the use of nitrogen, but a combination of the two gave still larger yields. The addition of potash to nitrogen and phosphoric acid resulted in a slight additional increase in yield. The use of lime was beneficial when used alone or with any of the fertilizer treatments. The heaviest yield of 8,857 pounds of green forage per acre was obtained from the use of a complete fertilizer on limed soil. However, phosphoric acid alone on limed soil produced 7,833 pounds of green forage per acre. Soil that received no lime or fertilizer produced only 2,767 pounds of green forage per acre, and 4,506 pounds when limed.

Horticultural Crops Investigations

Citrus: The Meyer lemon and Satsuma orange continue to be the most promising citrus fruit for this locality, and the yields of these are rather uncertain on account of injury by freezes. The yields on Satsumas were fairly satisfactory this season, but the yields of Meyer lemons were very light. The low yields were caused by cold injury to the buds just prior to blooming.

Pears: The two trees of hybrid pear, T. S. No. 7493, produced light yields of fruit this season. The yields were below normal on account of loss of fruit by strong wind while the fruit were rather small.

Tung Oil: The growth of the trees, which were planted in the spring of 1936, was very unsatisfactory this season. The yields of nuts were very low, being from nothing to slightly above one pound per tree of shelled nuts.

R. H. Wyche.

Rice Investigations

In cooperation with the Division of Cereal Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture)

Variety Test: Thirteen rice varieties were grown in the replicated /50-acre field plot variety test in 1939. Single plots of 10 hybrid selections were also grown. The varieties grown in replicated plots were divided into early, midseason, and late maturity groups and each group was sown as a separate randomized block test. Early Prolific and Zenith were the highest yielding varieties in the early maturity group with yields of 32.3 and 31.9 bushels per acre, respectively. Shoemed, grown as a check variety, yielded 31.5 bushels per acre. Four hybrid selections were grown in single plots adjacent to the early maturing group. A selection from the cross Colusa x Blue Rose was the highest yielding hybrid selection with a yield of 33.9 bushels per acre. This selection is a medium-grain type with relatively short straw that matured slightly earlier than Early Prolific. Other hybrid selections in this group produced rather poor yields as compared to the Colusa x Blue Rose selection and adjacent Early Prolific plots. Fortuna, with an average yield of 8.2 bushels, was the highest yielding variety in the midseason group, and Acadia was second with a yield of 35.7 bushels. Shoemed averaged 3.8 bushels per acre in the midseason group. Rexoro was the highest yielding variety in the late maturity group, averaging 44.2 bushels per acre. Blue Rose yielded 37.2 bushels and Shoemed 31.3 bushels per acre. Six midseason and late maturing hybrid selections were grown in single plots adjacent to the late group. A Kameji x Blue Rose selection obtained from the Rice Experiment Station, Crowley, Louisiana, producing 40.6 bushels per acre was the highest yielding hybrid selection in this group. This selection is a medium-grain type maturing along with Blue Rose and is resistant to *Cercospora oryzae*. A short-grain Caloro x Lady Wright selection of midseason maturity ranked second with a yield of 30.6 bushels per acre. A midseason Rexoro x Delitus hybrid selection with a grain type similar to Rexoro yielded 32.6 bushels per acre.

Nursery Experiments: The advanced yield nursery consisted of 125 varieties and selections that were divided into early, midseason, and late maturity groups. Yields in the early group ranged from 38.0 bushels per acre for an Edith x Fortuna selection to as low as 22.7 bushels for a Lady Wright selection obtained from the Biggs Rice Field Station, Biggs, California. The second highest yielding variety in the early group was Colusa x Blue Rose selection which was also grown in the field plot test. This selection yielded 35.7 bushels per acre as compared to yields

of 30.6, 30.1, and 23.7 bushels for Edith, Early Prolific, and Lady Wright respectively. Zenith yielded 31.1 bushels per acre.

The midseason group of the advanced yield nursery ranged in yield from 40.0 bushels for an Improved Blue Rose x Fortuna selection to 20.0 bushels for Delitus. Fortuna ranked ninth with a yield of 36.3 bushels. Nira and Shoemed yielded 30.9 and 30.3 bushels, respectively. A Calor x Lady Wright selection which was also grown in the field plot test yielded 36.9 bushels. Other promising varieties or selections yielding higher than Fortuna were two Kameji x Blue Rose selections, Hay Ozeki (a Japanese variety), and a Rexoro x C. I. 7689 selection. The C. I. 7689 parent was an Indian patna variety.

C. I. 5548, a short-grain variety with a yield of 45.6 bushels per acre, was the highest yielding variety in the late group. An unnamed Japanese variety, which is being grown commercially in the Beaumont area, was the lowest yielding variety in the late group with a yield of 26.1 bushels per acre. Blue Rose, Rexoro, and Acadia yielded 41.8, 37.4, and 36.6 bushels per acre, respectively. A Blue Rose selection obtained from the Rice Experiment Station, Crowley, Louisiana, that is resistant to *Cercospora oryzae* yielded 43.0 bushels and Asahi, a Japanese variety which is being grown commercially in the Beaumont area, yielded 37.9 bushels.

A preliminary yield nursery of 103 varieties and selections was grown in 1939. Approximately 15 selections from this nursery will be grown in the advanced yield nursery in 1940. A large number of selections will be discarded to make room for promising hybrid selections saved from the space sown breeding nursery.

A source of seed experiment in which seed of four varieties obtained from Arkansas, Louisiana, California, and Texas were tested in replicated nursery plots was grown for the third season. The results so far have failed to show any significant differences in yield due to source of seed.

A method-of-seeding experiment comparing the direct method of seeding with the transplanting method has also been conducted for three seasons in replicated nursery plots using three varieties. In 1939 no significant differences between the two methods were obtained.

Four-hundred and twelve rice introductions from Japan and other Asiatic countries were grown for the purpose of maintaining viable seed and for determining reaction to prevailing diseases.

The space-sown breeding nursery included 1,440 panicle rows representing selections from advanced generation crosses. Approximately 300 selections from this nursery were saved for testing in a preliminary yield nursery in 1940. A large number of selections were discarded to make room for more promising selections saved from F_2 populations grown in 1939. Eighteen F_2 populations were grown for varietal improvement purposes in 1939. Most of these populations represented crosses between

promising hybrid lines many of which showed more resistance to *Helminthosporium oryzae* and *Cercospora oryzae* than commercial varieties. Forty-one F_2 backcross populations of the combination F_1 (Storm Proof Spain Jap selection x Supreme Blue Rose) x Supreme Blue Rose were also grown in 1939. The Storm Proof x Spain Jap selection is a hybrid line showing marked resistance to both *Helminthosporium oryzae* and *Cercospora oryzae* but has poor grain shape and quality. The object of this backcross is to obtain Blue Rose types resistant to both diseases. The Blue Rose variety is highly susceptible to both *Helminthosporium oryzae* and *Cercospora oryzae*. A large number of selections appearing to possess the desired characteristics were saved for growing in space own rows in 1940.

Date of heading and other segregating characters were recorded on six F_2 populations during the 1939 season. This was a continuation of inheritance studies started in 1936.

The disease nursery consisted of 329 varieties and selections sown in two dates. Hybrid selections from the crosses Colusa x Blue Rose, Blue Rose x Carolina Gold, and Blue Rose x C. I. 5309 were quite resistant to *Helminthosporium oryzae*. Varieties and selections resistant to *Cercospora oryzae* were Acadia, Rexoro, Nira, and hybrid selections from the crosses, Rexoro x Delitus, Rexoro x Supreme Blue Rose, Rexoro x C. I. 5094, Rameji x Blue Rose, Kameji x Honduras, Kameji x Shoemed, Nira x Kameji, C. I. 81C x Kameji, Latex x C. I. 4700, and Caloro x Fortuna. Hybrid selections from crosses showing resistance to both *Helminthosporium oryzae* and *Cercospora oryzae* were Storm Proof x Spain Jap selection x Nira, Storm Proof x Spain Jap selection x Supreme Blue Rose, and Kameji x Honduras.

H. M. Beachell and E. C. Tullis.

Physiology and Diseases of Rice

The Effects of Magnesium and Calcium on "White Tip": Injury similar to "white tip", a chlorosis of leaf tips of rice in the field, was obtained in plants grown in soil and water cultures low in magnesium. As indicated in Bulletin 584, the injury was corrected by the addition of magnesium and calcium. Applications of magnesium or calcium alone were injurious to the plants, but the greatest benefit occurred when the calcium ratio to magnesium was 1:1 or 1:3 when calcium and magnesium were present in concentrations of 27, 81, or 243 ppm. of each element. Experiments in progress indicate that there may be other factors contributing to this condition.

Rice Straight Head: Field experiments using sodium nitrate up to 100 pounds per acre with straw at the rate of 3 tons per acre and greenhouse experiments with the nitrate varying from 15 to 960 pounds per acre plus straw or horse manure produced taller plants and greater yields of seed, but failed to produce straight head. When 240 pounds of sodium

nitrate and 500 pounds of sulfate of ammonia were applied, the plants attained the typical dark green color and luxuriant growth associated with the straight-head disease. These plants matured nearly a month after those of the other treatments and showed typical straight-head symptoms.

Soil Acidification Experiments: A sample of soil from Hampshire Texas which was alkaline in reaction was treated with sulphuric acid so as to change the pH reaction from 7.8 to 6.5. Other samples were supplied at the time of seeding with sulphur at rates of 500, 1000, and 2000 pounds per acre. Still other samples were irrigated with acidified water with reactions of pH 4 and 5. The best yields were obtained with the acidified soils and by irrigating with acidified water. These yields approached the normal seed production for good rice land while certain other treatments and the controls made yields far below normal.

Black Kernel Disease: Rice plants grown in the greenhouse were inoculated by injecting the seeds with an aqueous suspension of spores of *Curvularia lunata* or by dipping the heads into this suspension. Practically all seeds injected with the spores had small brown or black spots where the needle had entered. Eight per cent of these seeds were black when harvested but when incubated at 35° C. in a moist chamber, 62 per cent of them became black. Eleven per cent of the seeds of dipped heads were black on maturing while 32 per cent became black after incubation at 35° C. This indicates that many infected kernels may not become black kernels unless they become damp and heated in the shock or stack. Since inoculations made during the milk stage were the most effective and most insect punctures occur during this stage, it is possible that insects moving from seed to seed might carry the spores of *C. lunata* and spread infection throughout the field.

Petri dishes containing a sterile rice agar medium were exposed for about 10 seconds to the dust stirred up around over-wintered rice-straw stacks. The exposed dishes were incubated at 35° C. for six days and examined for fungus colonies. Although many non-pathogenic fungi were obtained, *Curvularia lunata* was present in practically all exposures made near stacks in fields where black kernels were found the previous year. The number of colonies obtained was directly proportional to the severity of the previous infection.

Various fertilizer and seed treatment tests showed no effect on the incidence of black kernel.

A. L. Martin, C. E. Minarik.

Rice Diseases

The Effects of Magnesium and Calcium on "White Tip": The injury observed on leaves of rice plants in soil and water cultures, which were low in magnesium content, was similar to a chlorosis observed in the field

and known as White-tip. This condition was eliminated in soil cultures when 81 ppm. of magnesium were added and in water cultures when 27 ppm. were present. However, these concentrations of magnesium produced toxic effects such as stunting and decreased yields, and normal plants were obtained only when calcium as well as magnesium was supplied to the cultures. Calcium was not toxic in low concentrations in soil cultures. In magnesium-free water cultures 9 ppm. or more produced stunting and brown leaf spots. These injurious effects were overcome when sufficient magnesium was present. The greatest benefit from the antagonistic action between magnesium and calcium occurred with the magnesium: calcium ratios of 1:1 or 1:3 when calcium and magnesium was present in concentrations of 27, 81 or 243 ppm. Experiments now under way indicate that there may be still other conditions causing the appearance of white tip.

The Straight Head Disease: Sodium nitrate up to 400 pounds per acre on land which had been idle for 12 years failed to produce any symptoms of the straight head disease. The addition of straw at the rate of 3 tons per acre with the nitrate also failed to produce the disease in the field but the land to which the straw had been added had much taller plants and produced greater yields of seed. The seed yield also was directly proportional to the amount of nitrate applied. Experiments in the greenhouse with the nitrate varying from 15 to 960 pounds per acre and the same amounts plus straw and plus horse manure added to the soil also failed to produce the straight head disease and the seed yields were increased noticeably. However, when 240 pounds of sodium nitrate was applied with 250 and 500 pounds of sulphate of ammonia, the plants had the typical dark green color and luxuriant growth found with the straight head disease. The plants in this soil matured nearly a month after those with the other treatments and showed typical straight head symptoms. It seems doubtful, however, that such extremely high concentrations of nitrogenous fertilizer would be found under the conditions of ordinary rice culture.

Inoculating Rice Seeds with the Black Kernel Disease: Rice seeds produced on plants grown in the greenhouse were inoculated by injection with an aqueous suspension of spores of *Curvularia lunata* and by dipping the heads into this same suspension. Practically all seeds injected with the spores had small brown or black spots where the needle had entered. Eight per cent of these seeds were black when harvested but when incubated at 35° C. in a moist chamber 62 per cent of them became black. Eleven per cent of the dipped seeds were black on maturing while 32 per cent of them were black after incubating. This indicates that many infected kernels may not become black unless they became damp and rot in the shock or stack. Inoculations made during the milk stage were the most effective. Since most insect punctures occur during the milk stage it is possible that insects in moving from seed to seed might carry the *C. lunata* spores and spread infection throughout the field.

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Fungi Recovered from the Dust from Straw Stacks: In order to show that dust from threshing and from rice straw stacks might be responsible for infecting rice grains with the black kernel disease, petri dishes containing a sterile rice agar media were exposed for about 10 seconds to the dust stirred up around these stacks. The exposed dishes were incubated at 35° C. for six days and examined for fungus colonies. Although many non-pathogenic fungi were obtained, *Curvularia lunata* was present in practically all exposures made near stacks in fields where black kernel were found the previous year. The number of colonies obtained was directly proportional to the severity of the previous infection.

Sulphur and Sulfuric Acid Experiments: A sample of soil from Hampshire, Texas, which was alkaline in reaction, was treated with sulphuric acid so as to change the pH reaction from 7.8 to 6.5. Other samples were supplied at the time of seeding with sulfur at rates of 500, 1,000, and 2,000 pounds per acre. Still other samples were irrigated with acidified water with reactions of pH 4 and 5. The best yields were obtained with the acidified soils and by irrigating with acidified water. These yields approached the normal seed production for good rice land while certain other treatments and the controls made yields far below normal.

The Influence of Various Fertilizer Treatments on the Number of Black Kernels and the Yield of Rice: Tests made with different fertilizers at Beaumont showed that the most practical fertilizer to apply was either a combination of ammonium sulphate and superphosphate in a ratio of 4 to 8 at a rate of 126 pounds per acre or straight superphosphate at 126 pounds per acre. The best results were obtained at Katy with a combination of the above two fertilizers with 40 pounds of muriate of potash per acre making a fertilizer ratio of 4-8-4. There was no evidence that any of the fertilizer treatments tried had any effect on the number of black kernels produced.

The Influence of Various Seed Treatments on the Number of Black Kernels Produced: Black kernels were completely lacking in the Ceresant-treated seed plats, but the yield of rice per acre was reduced by 200 pounds in contrast with untreated rice plats. Lime and sulfur and copper carbonate seed treatments increased yields over the controls, but had no influence on the number of black kernels produced.

A. L. Martin, C. E. Minarik.

SUBSTATION NO. 5, TEMPLE

(In cooperation with Soil Conservation Service U.S.D.A.)

The Blackland Experiment Station, or Substation No. 5, is located two miles south of Temple and one-half mile west of the Temple-Taylor highway No. 95. The latitude is 31° 3' north, the longitude 97° 21' west and the elevation 660 feet above sea level. The average annual rainfall over a period of 27 years, 1913 to 1939, inclusive, is 34.54 inches, while

For 1939 it was 24.46 inches. During the 27-year period an average of 44 inches of rain fell in the months of June, July, and August. The rainfall for these months in 1939 was 6.35 inches. The 27-year average rainfall for the six-months period, May to October, inclusive, is 17.66 inches, while 11.15 inches fell during these months in 1939.

The station consists of a total of approximately 547 acres of land. The soil on the station is typical of the Blackland region and is predominantly of the Houston series. All land is in cultivation except that occupied by farmsteads, roads, ditches, and natural drainage ways. There are approximately 34 acres of pasture along Boggy Creek, which is the major drainage way through the station.

The purpose of this station is to aid the development of the agriculture of the Blacklands, particularly through the solution of the major crop and soil problems of the region. The soils of the region that have been well preserved are very fertile and are admirably adapted to the growing of cotton, corn, grain sorghums, and small grain. The objectives of this station are: the control of the cotton root-rot disease; the prevention of soil erosion; the introduction, testing, and improvement of crop varieties; the improvement of soil fertility; and the study of various cropping systems. The cotton root-rot problem is being studied by the station under supervision of the Division of Agronomy and the Division of Plant Pathology and Physiology of the Texas Agricultural Experiment Station and in cooperation with the Bureau of Plant Industry of the United States Department of Agriculture. The Work Projects Administration is also cooperating with the station in the study of root-rot. The soil and water conservation problem of the area is being studied by the Soil Conservation Service, Division of Research, of the United States Department of Agriculture, in cooperation with the station. During the last three years, livestock projects to supplement cotton farming have been instituted.

Cotton Root Rot Investigations

(In cooperation with Bureau of Plant Industry, U. S. D. A.,
and with Works Projects Administration.)

Cotton root rot on this station farm appeared earlier in cotton in 1939 than in any previous year. A number of small seedlings were found dying on May 23. There was a comparatively low end season infection throughout central Texas, but due to the fact that the disease appeared early and spread rapidly, there was a high proportionate loss. These investigations were materially aided by the Works Projects Administration, Project No. 10304.

Number and Viability of Cotton Root Rot Sclerotia from Areas Planted to a Four-Year Rotation of Cotton-Oats, Sorghum-Corn and from Continuous Cotton Area: Soil samples for sclerotial analysis were taken from the four-year rotation (variety tests) located on acres A-2, B-2, C-2, and D-2 on the substation and from continuous cotton on acre E-1. Samples

were taken at the rate of 320 postholes per acre to the 3-foot depth with a 6-inch auger. An average of 2335 sclerotia were found in the rotation, 828 or 35.5 per cent of which were viable. A total of 4930 sclerotia were found in the continuous cotton area, 3259 or 66.1 per cent of which were viable. In both cases most of the sclerotia were found in the second foot level.

Effect of Five Years Continuous Grass on Cotton Root Rot and on the Number and Viability of Sclerotia: About half of acre H-1 on the substation that had been in grass plots for approximately five years was planted to cotton in 1939. A very good growth of cotton plants was obtained on the acre. A few root rot centers of infection appeared, but there was very little spread. Soil samples for sclerotial analysis were taken at the usual rate of 320 postholes per acre. These samples were taken to a depth of four feet. A total of only 254 sclerotia were found, 102 or 40.2 per cent of which were viable. Fourteen sclerotia were found in the fourth foot, 12 of which were viable. This area had a high infestation of root rot when the station was established. Apparently this continuous grass served to eliminate a high percentage of root rot.

Sampling for Sclerotia in Areas on Which Four Two-Year Rotations Have Been Started: Soil samples for sclerotial analysis were taken to the 3-foot depth on acres C-6, D-6, G-6, and H-6. Duplicate 2-year rotations by quarters were started on these four acres in 1938. Green manures are incorporated in each rotation. In order to have comparative data at the beginning of these rotations, these samples for sclerotial analysis were taken during the winter of 1938-39 and in the spring of 1939. Sclerotial content varied from a high of 13,752 on the first quarter of acre D-6 to a low of 1,392 sclerotia on the second quarter of acre H-6. Viability varied from a high of 73.6 per cent for sclerotia from the fourth quarter of acre C-6 to a low of 22.1 per cent for sclerotia from the third quarter of acre H-6.

Samples were taken to a depth of four feet by 6-inch intervals on acre D-6. A number of viable sclerotia were found in the fourth foot both in the 36-42 inch and in the 42-48 inch depths.

Cotton Root Rot After Approximately 10 Years of Clean Fallow Twelve rows on acre E-6 were planted to cotton in 1939 for the first time after approximately 10 years in clean fallow. Such a procedure has been followed each two years since 1934. The entire acre was started in clean fallow in 1930. A few plants were killed by cotton root rot as early as June 15 and at the end of the season on September 15, 51.1 per cent of these plants were killed. In another 12 rows that had been in continuous cotton for three years following approximately 8 years clean fallow there was an end-season root rot kill of 65.2 per cent. At the last sampling there were large quantities of viable sclerotia in this long time fallow area.

Another area, acre G-2, was started in clean fallow in 1934. Twelve rows were planted to cotton on this acre following four years clean fallow. This is on a lighter soil than the clean fallow on acre E-6. Root rot appeared in this area on July 1 and there was an end-season kill of 38.3 per cent. Three years continuous cotton on this same area following two years clean fallow had an end-season root rot kill of 82.1 per cent.

Root Rot in Cotton Following Continuous Sorghum: Twelve rows on acre H-2 were planted to cotton in 1939 after four years of continuous sorghum. Root rot appeared in this cotton on July 1 and there was an end-season kill of 66.5 per cent. Another 12 rows on the same acre have been planted three years to cotton following two years sorghum. Root rot appeared in this cotton on July 1 and by September 15, 82.8 per cent of the cotton was killed.

Residual Effect of Oil and Ash Treatment on Cotton: Cotton was planted on plots treated with crude oil and crank case drainings in the fall of 1937 at rates of 2000 to 15000 gallons per acre and cotton bur ashes at rates of from 2000 to 15000 pounds per acre. Germination of seed was approximately the same on all plots. However, shortly after germination, the plants on plots treated with 8000 and 15000 gallons of oil became red and stunted. There was some toxic effect of oil on cotton on both the 2000 and 4000 gallons per acre rates. Yields at the lighter rates of application were approximately the same as from the check, but root rot in all plots where oil was applied was much less than in the checks. There was no root rot in any of the crank case oil applications, the checks averaging 28.1 per cent root rot. In the crude oil applications root rot was highest at 7.1 per cent in the 2000 gallon per acre rate, whereas the checks averaged 51.2 per cent root rot. Cotton bur ashes had no appreciable effect on germination or yield, but there was a smaller amount of root rot on all treated plots than on the checks. The highest amount of root rot was 15.9 per cent in the 2000 pound per acre rate as compared to 25.8 per cent root rot in the checks.

The Effect of Depth of Application of Crude Oil on Germination of Cottonseed, Cotton Root Rot, and Yield of Cotton: Since oil applied in the furrow for the 1938 crop had a very deleterious effect on cotton seedlings and plants although there were big reductions in root rot, in 1939 oil was applied at depths of 5 inches, 12 inches, and 18 inches. These applications were made in the furrow following a tractor-drawn Killefer, reaching a depth of 18 to 20 inches, a horse-drawn chisel, reaching a depth of 12 inches, and following a turn plow where two furrows were thrown out following the bedding plow. Oil was applied at rates of from 1000 to 8000 gallons per acre. With increase in depth of application there was increase in germination of cotton seed. There was a smaller amount of cotton root rot where the oil was applied deeper in the soil. Yields of cotton were highest where 1000 gallons of oil were applied at a depth of 18 inches. A yield of 680 pounds of seed cotton was obtained from these plots compared to 578 pounds from the accom-

panying checks receiving no oil treatment. The checks on plots that were plowed the deepest yielded a greater amount of seed cotton than the checks from the other plots.

Effect of Various Soil Treatments on Cotton Root Rot in Cotton, Rose, and Privet: Pits were excavated 3 feet wide to a depth of 3 feet and varying quantities of copper sulfate, iron sulfate, sulfur, crude oil, and formalin were mixed with the soil as it was replaced in the pits. Cotton, rose, and privet were planted in these pits. These plants were inoculated three times and irrigated at intervals during the growing season. Almost all treatments gave some control of root rot as compared to the checks. Best results were obtained from copper sulfate or from mixtures of copper sulfate with the other chemicals.

Cotton Seed Treatment Studies: Cotton seed were treated with Ceresan (2 per cent), New Improved Ceresan (5 per cent), Sanoseed, powdered copper sulfate, yellow copper oxide, delinted with sulfuric acid, and delinted with sulfuric acid and subsequently treated with Ceresan, New Improved Ceresan, and Sanoseed. These seed were planted on April 3 and April 29 at the rates of 2, 5, and 10 seed per hill, 18 inches between hills, in 3-foot rows. All treatments gave increased germination, less seedling infection, and higher cotton yields. Acid delinted seed and New Improved Ceresan treated seed generally gave best results. There was from 10 to 50 times more seedling infection in untreated plots than in treated plots. Germination was over twice as great in delinted and in Ceresan, New Improved Ceresan, and delinted followed by treatments of Ceresan and New Improved Ceresan, as in the check plots. The highest single average yield of 1067 pounds seed cotton per acre was obtained from plots delinted and treated with New Improved Ceresan. This yield was from plots where 2 seed per hill were planted. Highest yields were obtained from the 2 seed per hill rates where seed were planted on the early date of April 3. Around 1000 pounds seed cotton per acre were harvested from the best treatments at the 2 seed per hill rate planted on April 3. Two seed per hill, 18 inches apart, represents about half a peck of seed per acre.

Germination of Cotton Seed from Plants Killed by Cotton Root Rot at Different Dates in 1938: Cotton seed harvested from plants killed at 15-day intervals beginning July 15 during the 1938 growing season were planted in 1939. Germination of such seed varied from a low of 11.5 per cent for seed from plants killed July 15 to a high of 68.2 per cent for seed from plants killed September 15. Seed from plants remaining green on October 1, 1938, gave a germination of 75.0 per cent. Yields of cotton increased from 308 pounds seed cotton per acre for seed from plants killed August 1 to 1078 pounds for seed from plants killed September 15, 1938. Seed from those plants remaining green on October 1 gave a seed cotton yield of 1122 pounds per acre.

Fertilizer-Rotation Test: In 1938 a fertilizer-rotation test was started in cooperation with the Bureau of Plant Industry, U. S. Department of

Agriculture, to determine the effect of various commercial fertilizers and manure on the fertility, yield, and root rot infestation of an area when used in combination with a four-year rotation of cotton-oats-corn-grain sorghum and also when used on continuous cotton fertilized once in four years and on continuous cotton fertilized every year. Fertilizer was applied to the cotton plats for the first time in 1939. Barnyard manure increased yields 101 pounds per acre over the check in the rotation, 119 pounds in the continuous cotton fertilized every year, and 156 pounds in continuous cotton fertilized once in four years. Root rot for the manure treatment was 28.6 per cent in the rotation compared with 36.0 per cent in the accompanying checks, 24.0 per cent in continuous cotton fertilized once in four years compared with 34.3 per cent in the accompanying checks, and 27.4 per cent in continuous cotton fertilized every year compared with 50.2 per cent in the checks for this area. Commercial fertilizer 60-20-20 increased cotton yields 52 pounds per acre over the check in the rotation. Root rot in the 60-20-20 treatments was 25.7 per cent in rotation, 27.7 per cent in continuous cotton fertilized once in four years, and 39.4 per cent in continuous cotton fertilized every year, as compared to the above checks. An average of root rot percentages for the same treatments in rotation and continuous cotton showed that there was less root rot in all treatments than in the checks; the manure and the 60-20-20 treatments, however, gave greatest reductions. This test has not been under study sufficiently long for the rotations to be effective.

C. H. McDowell and C. H. Rogers.

Yields and Resistance to Root Rot of Different Varieties of Cowpeas: Selections have been previously made of cowpeas showing resistance to root rot from the Iron and Brabham varieties. These were planted along with Whippoorwill, White Crowder, Blackeye, Cream, and commercial sources of Iron and Brabham varieties in 1939. Brabham selection gave the lowest root rot infection of 24.5 per cent. Blackeye was most susceptible to root rot with 57.5 per cent of the plants being killed. The commercial sources of Iron variety showed a lower root rot infection than the Iron selection. The Brabham selection gave the highest green forage yield of 7,754 pounds per acre. The commercial source of Iron, however, gave a slightly higher yield of dried forage than the Brabham. Iron yielded 2,091 pounds air-dried forage per acre. Blackeye yielded 883 pounds seed per acre, which was over twice the average yield of any other variety. Neither the Iron nor Brabham varieties show the severe chlorosis typical of most cowpeas planted in the alkaline soils of the Blackland region and grown during periods of comparatively dry weather.

C. H. Rogers.

Soil and Water Conservation Investigations

(In cooperation with the Soil Conservation Service, U. S. D. A.)

Soil and water conservation investigations at the Blackland Experiment Station have been in progress since 1929. This work is applicable to the Blackland region of Texas and to parts of the Grand Prairie.

General Control Plat Work: Soil and water losses are measured from 22 small control plots to test the soil and water conserving ability of different plant covers, cropping treatments, and land characteristics, such as degree of slope and slope length. The results from these plots serve as indicators to soil and water conservation practices for field application. The results from this study were briefly enumerated in the Fifty-first Annual Report of the Texas Experiment Station, page 155.

Terrace Investigations: The year 1939 completed a 10-year study of terrace design characteristics such as grade, vertical spacing, length, and terrace cross sections. The leased land upon which these studies were conducted was returned to the lessors at the end of the year. The results of this study are briefly summarized as follows:

1. Level terraces with closed ends cannot be used satisfactorily in this area on Houston black clay soils.

2. Level terraces with closed ends and 4-inch tile drains two feet under the terrace channel perform no better than closed-end terraces on Houston black clay soils.

3. Level terraces have a tendency to drown out crops in the channel and to interfere with timely farm operations.

4. Terraces with a variable grade of 0 to 3 inches per hundred feet drain satisfactorily and the soil losses are not excessive. This grade of terrace is more satisfactory than a constant grade of three inches from a standpoint of soil and water losses.

5. Soil losses decrease with a decrease of vertical spacing. Terraces with vertical spacing as recommended by the Texas Extension Service and by the various U. S. Department of Agriculture bulletins have performed satisfactorily at this Station. A simple formula for the U. S. D. A. spacing is vertical interval equal to slope of land plus eight divided by four ($V = \frac{S + 8}{4}$).

6. There is no optimum length of terrace from the standpoint of soil and water loss. The location of a desirable and economical terrace outlet in most cases determines the length.

7. Terraces up to 2,000 feet in length have performed satisfactorily at this Station. Occasional storms have endangered terraces of this length which have discharged 13 cubic feet per second.

8. Cultivation across terraces is more economical than cultivation parallel to the terraces but the soil loss was 50 per cent greater where the rows cross the terraces. This study was not continued a sufficient length of time for the results to be conclusive.

9. Maintenance of terraces at the Station has been with blade maintainers of various types. The terraces have been maintained to an average height of 18 inches. The terraces built in 1930 and 1931 were main-

tained in 1932, 1934, and 1937, and are now in a good state of repair with an average height of between 15 and 18 inches. The type of maintenance, both with breaking plows toward the terrace ridge and with blades, has tended to increase the base width of from 25 to 30-35 feet. Operation of tractors on this cross section has been very satisfactory.

10. Terraces of recommended design have an average soil loss of 2.50 to 3.75 tons per acre per year. Water conservation is not so great as soil conservation—the average run-off being about 12-15 per cent. This percentage increases during wet years.

Terraces with Strip Cropping: In the fall of 1939 two pairs of terraces were designed for a comparison of the soil and water losses between terraces without strip cropping and similar terraces with an erosion resisting strip crop, oats, immediately above the channel, taking up the point rows within the terrace intervals. Terracing has proved to be a very effective soil conservation measure. Loss of 54 tons per acre per year has been reduced to 3.75 tons per acre per year by terracing. It is believed that the use of strip cropping with terracing will cut this 3.75 ton loss still lower, but it is recognized that regardless of the amount which the latter loss is reduced, the reduction will not be nearly so important as that obtained by changing cultivation from up and down the hill to terraced land farming, which reduces the soil loss from 54 to 3.75 tons per acre per year.

Strip Cropping Investigations: During 1939 twelve plots, one and a half acres in size, were laid out, and installations were completed for the measurement of soil and water losses. These plots will be used to compare the soil conserving ability of a strip cropping system with that of a straight crop rotation, the same crops being used in both treatments, and also with that of solid crops. Six large field areas were also planted to strip crops during 1939. These various field areas cover a wide range of slopes and slope lengths, and the strips are of different widths and different ratios of erosion-permitting to erosion-resisting crops. Different crops are being used under similar conditions as erosion-resisting strips in the system. All of these factors are to be considered in the satisfactory performance of a strip cropping system, and on these field areas evaluation surveys will be attempted to determine the conditions limiting strip cropping as a soil conserving measure.

Only two run-offs have been recorded from the field areas this year, and neither of these was very large. The lack of run-offs prevents any indication of probable trends. A more detailed explanation of the strip cropping project was given in the Fifty-first Annual Report of the Texas Experiment Station.

Protection of Eroded Land by Revegetation—Grasses: Approximately 100 species of grass are under observation at this station. These grasses are being tested for their adaptability to the area and for use on eroded

lands to be revegetated, for meadow and forage, and for general utilization. During 1939 most of the commercially available grass seed of this country and some from foreign countries were planted. In the spring only a few came up, but out of the fall planting about 80 per cent have come up to a good stand. Of the imported grasses, Toowoomba Canar grass (*Phalaris tuberosa*) looks best. All of the grasses under study are perennials.

Soil Movement: Soil movement lines have been run on the terraced farm since 1931. A 9-year period of record shows the soil that has been placed on the terraces in successive maintenance and farming operations, and also shows a general decrease in elevation of six inches to a foot for the remaining field areas. There is no difference in the soil movement line at the top of the slope and at the bottom of the slope. The soil movement indicated is far in excess of that which has been lost through the terrace outlets. The expansion and contraction of the Blackland soils have considerable effect on the elevation of the soil as recorded by the soil movement lines. In February, 1939, six bench marks were made by filling 8-inch auger holes with reinforced concrete. The length of these bench marks was 3, 5, 8, 10, 15, and 20 feet into the ground. Using the 20-foot marker as a base, all of the other bench marks have moved from 5/1000 to as much as 1/10 foot. This movement is undoubtedly due to the expansion and contraction of the Blackland clay soils with varying moisture content. It is entirely possible that the 20-foot marker is moving also.

H. O. Hill.

Agronomic Studies

In the general crop and soil experiments conducted on the station an attempt is made to furnish not only the basic information upon which the cotton root rot and soil and water conservation investigations are predicated but also to supplement these specialized studies in such a way as to complete a well-balanced research program on crops and soils for the Blackland region. The work specifically treated in this section is only that part of the field work for which a progress report is justified at this time.

Cotton Variety Test: A variety test of cotton has been conducted at this station since 1928. Of the 36 varieties grown in 1939, the highest yielding varieties in order of production are: Bryant Mebane, 389 pounds lint cotton per acre; Watson 373 pounds; Buckellew Bros. Mebane, 369 pounds; Hurley Special, 358 pounds; and Lankart, 327 pounds lint cotton per acre. A total of 17 varieties averaged 300 pounds or better of lint cotton this season; 13 varieties ranged in production between 250 and 300 pounds; and 6 varieties fell below an average of 250 pounds lint cotton per acre, to as low as 213 pounds per acre for Hi-Bred.

In a survey of the yields of the cotton varieties over the past ten-year period of the test, 11 varieties which have been grown each year are

taken as the standards, and an average of their yields for the entire period is taken as a basis on which comparable yields for all other varieties have been computed. The average acre yield of the standard varieties for the ten-year period is 283 pounds lint per acre, and the averages of the leading varieties in ranking order as to yield on a comparable basis are as follows: Buckellew Bros. Mebane, grown for three years, 329 pounds; Rogers Acala 111, grown for 9 years, 326 pounds; and Watson, grown for 7 years, 325 pounds lint cotton per acre.

Staple length for the different varieties for the ten-year period has ranged from as high as 1-1/16 inches to as low as 13/16 inch. Leading long staple varieties grown for two or more years are Lentz Acala, New Mexico College Strain Acala, Shafter Acala, and D. & P. L. 11A. Lankart has the largest boll size of all the standard varieties with an average boll weight of 7.25 grams. Of all other varieties, Lankart x Wacona, grown for 2 years, had the largest bolls with an average boll weight of 7.30 grams.

Corn Variety and Hybrid Test: A corn variety test has been conducted at this station since 1928. In 1939 this test included 17 commercial varieties which are in general use in Texas and 91 hybrid strains and varieties, or a total of 108 different varieties. The increasing interest in the adaptability of the northern hybrid corn varieties to culture and use in Texas led to the inclusion in this test of 54 hybrid strains of corn developed in the northern states. The other 37 hybrids planted in 1939 were crosses with Yellow Surcropper developed in Texas. Yields ranged from 51.9 bushels shelled grain per acre for Yellow Surcropper x 123B to 18.6 bushels shelled grain per acre for Ferguson Surcropper. In general, the crosses with Yellow Surcropper were the most productive, the first 13 ranking strains in the test being crosses with this variety. Of the 54 commercial hybrids under test, not a single one was significantly higher in yield than the best open-pollinated varieties. Average ear worm damage in commercial hybrids was 79 per cent as compared to 54.8 per cent in open-pollinated varieties. Increase in ear worm damage was accompanied by great increases in weevil damage, which was very obvious but not easily measured. Illinois hybrids appeared to be slightly better adapted than Iowa hybrids, but on the basis of this year's test, none can be recommended for the region represented by this station. All yields were higher from thick planting than from normal planting; however, the commercial hybrids showed a greater response to thick planting than commercial varieties. On the basis of a ten-year test, the following open-pollinated varieties are outstanding: Reese Drouth Resister, Surcropper, Nelson's Native Yellow, and Golden June. The most productive of the northern hybrid corn strains was Funk G-101 18-12. Although one of the yields for specific corn varieties were exceptionally high in 1939, the average production for the whole test was fairly good, and the results indicate the promising importance of the hybrid strains in future corn work.

Sorghum Variety Test: The sorghum variety test has been conducted on this station since 1928. This year the test consisted of 14 varieties, two of which had not been included in the test at this station before. The leading varieties in respect to grain yield in 1939 are as follows: Dwarf Yellow Milo, grown for two years, 43.2 bushels threshed grain per acre; Hegari, 43.0 bushels; and Double Dwarf Texas Milo, 42.5 bushels threshed grain per acre. Quadroon ranked fifth in grain production with a yield of 36.8 bushels per acre. In forage production, Leoti led with 5.74 tons dry forage per acre, followed by Darso No. 28 with 4.29 tons and Quadroon with 4.24 tons dry forage per acre. Over an 8-year period two varieties which have been grown each year are used as standards on which to base the comparable yields of the other varieties included in the test for periods less than eight years. The average of the standards for the period of years is 28.6 bushels threshed grain per acre and 3.15 tons dry forage per acre. During this period the three highest grain yielding varieties were as follows: Double Dwarf Texas Milo, 38.7 bushels; Quadroon, 37.4 bushels; and Dwarf Yellow Milo, 34.3 bushels threshed grain per acre. The two highest yielding varieties in respect to dry forage for the period of years were African Millet, with an average production of 4.78 tons dry forage per acre, and Leoti with an average yield of 4.26 tons per acre. This test is well suited to the needs of the farmers of this region, since they grow sorghums for two rather distinct purposes: grain sorghums are grown as a supplementary crop to corn in the production of grain and forage, while the sorgos are grown primarily for forage and hay.

Small Grain Rust Resistance Test: The small grain improvement work conducted at the Temple Station in 1939 consisted of testing 44 various strains of oats, 44 strains of wheat, and 11 strains of barley for rust resistance, yields, and general adaptability to growth in the Blackland region of the state. In addition to these varieties, 132 strains of wheat were grown in a supplementary test for yields.

The leading varieties of oats in this test in 1939 were as follows: New Nortex, 67.6 bushels threshed grain per acre; Appler x Bond 15-34-64, 66.5 bushels; Nortex x Victoria 11-34-103, 62.0 bushels; and Nortex x Victoria M19-21, 61.0 bushels. For the last three-year period of the test Nortex has been the most productive with a 3-year average of 61.6 bushels threshed grain per acre.

Yields in the rust resistance test of wheat ranged from 29.8 bushels threshed grain per acre to as low as 18.9 bushels. The most productive strains tested are as follows: Red May, 29.8 bushels; Selection 41-224, 28.9 bushels; Selection 41-203, 28.3 bushels; and Quivira, 27.1 bushels threshed grain per acre. The leading strains in the supplementary wheat test were: Hope x Martin Sel. 91 and Sel. 35; Hope x White Odessa Sel. 6; and Hope x Medt. 41-506. Stem rust affected only two varieties in the test this year, and leaf rust percentages were very low.

The most productive strain of barley tested in 1939 was Harland Hybrid 1-32-103 (rough awn) with a yield of 41.3 bushels per acre; this was followed by Harland Hybrid 1-33-7 (smooth awn) with 41.0 bushels, and Wintex with 37.3 bushels per acre. Yields in the barley test were generally much higher in 1939 than in 1938.

Oats Winter Hardiness Test: A winter hardiness test of oats was conducted at this station in cooperation with the Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C. Thirty strains were tested with germination percentages ranging from 94.0 per cent for Fulghum Tennessee 090 and Markton x Red Rustproof Georgia Sel. 209-4-11-20 to 69.0 per cent for Lee x Victoria Arkansas Sel. Pl-29-4-1. There was no apparent loss this year from winter killing due to very mild weather conditions.

Small Grain Date of Planting Test: In 1939 a test was made to determine the best date for planting wheat as revealed by data secured from plantings made on five different dates, namely: October 25, November 16, December 15, January 18, and February 7. Durum wheat was used and four replications were made of each planting. The October 25 planting yielded more grain and more straw than any of the other plantings with an average of 1.15 tons straw and 22.0 bushels threshed grain per acre. The average of the two years results, 1938 and 1939, shows the November planting to give the highest average yield of grain and straw. This test will be continued to secure reliable data over a greater period of years.

Sweet Clover Winter Hardiness Test: A sweet clover winter hardiness test was inaugurated at this station in 1939, with the Hubam and Melana clover varieties being planted in a comparative test, the plantings being made on three different dates. Seed for all three dates of planting in this test matured at the same time, so a composite harvest of all plants was made. Hubam, which flowered about 5 days earlier than Melana, yielded 560.2 pounds threshed seed per acre, in comparison with 399.3 pounds per acre produced by Melana.

Melana clover is a dwarf variety introduced to Texas from Canada in 1938. No winter killing was observed in the test on either Hubam or Melana this year as the minimum temperature was not low enough to cause severe freezing. This test will be continued next year on the same basis of testing for winter killing and seed production.

Castor Bean Variety Test: In 1939 a castor bean variety test was started at this station with the testing of eight varieties for seed production. Five varieties were included in an early planting and three other varieties were planted three weeks later. The early planted test was replicated four times, while the late planting was planted in triplicate. All varieties showed good germination and excellent stands were obtained from all plantings. The Common variety showed the worst tendency

toward shattering, with fully 90 per cent shattering. The Wagner, Conner, and Kolp Selections in the late planting did not shatter at all. All varieties showed great susceptibility to root rot, with root rot percentages ranging from 30 per cent to 66 per cent.

The highest yielding variety included was Flowering, which averaged 1,573 pounds of threshed seed per acre. This was followed by U. S. D. A. No. 7 with a production of 1,204.5 pounds and U. S. D. A. No. 4 with 1,036.8 pounds per acre.

Double Cropping Experiment with Sorghum: In 1939 a double cropping experiment of sorghum was started at this station with Quadroon and Sooner Milo being used in a comparative test of various methods of harvesting and second crop production. The purpose of this test is to determine the feasibility of growing two crops of grain from early varieties of sorghum which have favorable characteristics of side-branching and tillering habits. This test was planted in duplicate, each planting being replicated four times for each variety, and each replication was harvested in a different manner. The early planting of Sooner Milo was attacked by the milo disease (*Pythium* root rot) and only partial stands matured; therefore, Quadroon showed from four to five times as much production in the first planting as did the Sooner Milo. Yields of threshed grain in the late planting, however, indicate Sooner Milo as the more productive. The extremely dry weather during July, August, and September was very unfavorable for the growth of a second crop following the first harvest. No further side-branching or tillering occurred in either Quadroon or Sooner Milo after the first cutting, and the stalks remaining in the fields withered and died.

Hegari Strain Test: A test consisting of five different strains of hegari was inaugurated at this station in 1939 for the purpose of determining the comparative adaptability of the various strains to this section of Texas as measured by maturity, number of leaves, yield, and miscellaneous characteristics. This test was planted on three different dates: April 3, June 1, and August 1. The early planting was by far the most productive of grain, the yields of the five strains ranging from 54.4 bushels threshed grain per acre for Arizona Hegari to 50.3 bushels for Woodward Hegari. The second planting gave very poor yields for all strains due to lack of rainfall, but the late planting gave fair yields of grain with yields ranging from 28.9 bushels threshed grain per acre for Early Hegari to 15.9 bushels for Chillicothe strain. This test will be continued next year. Arizona Hegari led all other strains in the first two plantings in production of dry forage with 4.75 tons per acre for the early planting and 4.22 tons for the June 1 planting.

Cropping Systems

In 1939, fourteen different rotations were studied at this station as follows: two three-year rotations; three two-year rotations; two three-

year rotations with green manure planted on contour; two three-year rotations with green manure; and five two-year rotations with green manure crops. The rotations without green manure crops included have been under study since 1928. The two rotations planted on contour were started in 1938, and all other rotations including green manure crops were started in 1939. Several of the rotations studied in former years were dropped from the test this year as being unsuited to practical application. New rotations designed to include a crop to be turned under as green manure were instituted with the belief that the organic material returned to the soil as a result of the green manuring practice would prove a benefit to farming operations from the standpoints of both yield and soil conservation.

Cotton in Rotations: Cotton appears in all rotations under study. The highest cotton yield for 1939 was secured from a three-year rotation consisting of cotton-sorghum-oats, which produced 285 pounds lint cotton per acre as compared to the average yield of 208 pounds per acre on the continuous check acre. None of the rotations including green manure crops have been in practice long enough for the treatment to be effective.

In the period of years' survey for 1928 to 1939 inclusive, the results of the rotations as to cotton production show the rotation of cotton-corn ranking first with an average of 283 pounds lint cotton per acre. This was followed by the three-year rotation of cotton-sorghum-oats, with an average production of 263 pounds lint per acre for the 12-year period. The permanent check plats on the continuous cotton portion of acre F-6 ranged in average production for the period of years from 172 pounds to 260 pounds per acre, and the average for all checks on this acre for the 12-year period was 232 pounds lint cotton per acre.

Corn in Rotations: Corn was grown in 9 rotations in 1939 as follows: one three-year rotation; one two-year rotation; four three-year rotations including a green manure crop; and three two-year rotations including a green manure crop. The most productive of all rotations in regard to corn yields in 1939 was a three-year rotation consisting of cotton-oats-corn with oats for green manure, which averaged 36.0 bushels shelled corn per acre. The rotations including green manures surpassed those without green manure crops in yield of corn. The permanent check areas yielded an average of 36.2 bushels shelled corn per acre in 1939, which is higher than the yield of any rotated area.

Only two of the rotations with corn now under study have been in practice for longer than two years. Of these two, the rotation of cotton-corn has a 12-year average production of 34.6 bushels per acre in comparison with 28.9 bushels shelled corn per acre produced by the three-year rotation of cotton-corn-oats and with 28.8 bushels per acre for the permanent check plats on acre F-6.

Sorghum in Rotation: In 1939 sorghum was grown in a three-year rotation of cotton-sorghum-oats and in a two-year rotation of cotton-

sorghum. The three-year rotation gave an average yield of 48.4 bushels threshed grain per acre in 1939, while the two-year rotation gave an average yield of 44.2 bushels per acre. The continuous sorghum plats on the check acre produced an average of 46.2 bushels threshed grain per acre in 1939. Forage yields for both rotations and permanent checks were high this year, the three-year rotation leading in forage production with an average of 5.06 tons dry forage per acre in comparison with 4.23 tons for the two-year rotation and 4.33 tons for the continuous sorghum plats.

For the period of years the three-year rotation of cotton-sorghum-oats has been more productive of both grain and forage than either the two-year rotation or the permanent check acre.

Oats in Rotation: Oats appeared as a regular rotation crop in nine rotations on the station farm this year. The highest yield of oats was obtained from the two-year rotation of cotton-oats, which averaged 70.3 bushels threshed grain and 1.31 tons straw per acre. The second most productive rotation was that of cotton-corn-oats with sorghum for green manure planted on contour; this rotation yielded 66.1 bushels threshed grain and 1.04 tons straw per acre. The permanent check plats averaged 63.9 bushels threshed grain and 1.17 tons straw per acre in 1939.

Oats has appeared in only three rotations for the 12-year period, 1928-1939, inclusive. Of these rotations that of cotton-oats has the highest period of years average of 41.1 bushels threshed grain per acre and 1.33 tons straw per acre as compared to 38.6 bushels threshed grain and 1.32 tons straw per acre produced by the check plats as a period of years average.

Rotations with Green Manure Crops: Following the harvest of the regular crops in 1938 and in line with the newly planned rotations, oats, mustard, and barley were planted in the fall of 1938 to precede the 1939 cotton crop and were plowed under in the spring for green manuring. No data are available to show the yields of these crops or the estimated weight of green material turned under.

Sorghum and cowpeas were planted for green manure crops in both two- and three-year rotations following the harvest of the 1939 crops to determine the comparative value of each in increasing production and fertility of the soil and also in reducing root rot. This is the first year that green manure has been included in any except the contour rotations and the effect of plowing under green material will be reflected in the cotton crop of 1940. The highest yield of green forage in 1939 was 9900 pounds of cowpeas plowed under on the three-year rotation of cotton-corn-oats (cowpeas for green manure) appearing on the contoured area.

Cotton Root Rot in Rotations: Cotton root rot in all rotations except two was less in 1939 than in continuous cotton check plats. Root rot varied from a low of 1.6 per cent on one plot devoted to the rotation of cotton-oats-corn (oats, green manure) to a high of 86.2 per cent on one

of the permanent check plots. The average of all permanent check plats in 1939 was 55.8 per cent root rot. For the period 1928 to 1939, inclusive, the permanent check plats averaged 66.0 per cent root rot as compared with 41.4 per cent for the rotation of cotton-corn-oats, 51.6 per cent for the rotation of cotton-corn, 57.2 per cent for the cotton-sorghum-oats, 57.5 per cent for cotton-oats, and 68.2 per cent for cotton-sorghum. There has been a higher average yield of both cotton and grain in the two-year rotation of cotton-corn than in any other rotation on the station farm. It appears that those combinations wherein corn appears, especially where followed by cotton, give higher yields and serve better to reduce the infestation of cotton root rot.

C. H. Rogers.

Plant Introductions

During March and April of 1939 a total of 165 plants representing 14 species were received from the Division of Plant Exploration and Introduction, Bureau of Plant Industry, U. S. D. A., to include in the nursery tests on the substation. These plants are tested as to susceptibility to cotton root rot and climatic and soil adaptation. A number of bamboos were included in these lists to determine their value for ornamental purposes and for preventing soil erosion. Those plants that have given most favorable results so far during the last three years of introduction are: *Asparagus* sp., *Clerodendrum* sp., *Fraxinus* sp., *Ilex* sp., *Pyracantha* sp., *Eucalyptus* sp., and the bamboos.

C. H. Rogers.

Observations of Plant Diseases and Insects

Miscellaneous Plant Diseases: Diseases other than cotton root rot of any importance during the 1939 season were smut on oats, limb canker, a new disease (*Septobasidium sydowii* Couch) on hackberry, mildews on crape myrtle, coralberry, and rose, chlorosis of a number of ornamentals and vegetable crops, and bacterial blight on cotton. Leaf rusts appeared early in the season on small grains but did very little damage. Stem rust infections occurred later in the season on small grain and actually did little damage except on late crops. Powdery mildew was found in some cases in rather large amounts. Although the season was dry, cotton root rot did considerable damage in ornamentals. There was an unusually heavy infection of bacterial blight on cotton which may have been due in part to the small amount of sulfur dusting done to combat the cotton flea hopper.

Insects and Other Pests: Early infestations of lice on cotton, arborvitae, plums, and pecans did considerable damage. There was an early infestation of leaf hopper in cotton but due to the dry season these insects disappeared. Other insects of importance were leaf tier on redbud, termites, fleas, snails, and sowbugs in and about city homes, and bagworms on coniferous evergreens and shade trees.

C. H. Rogers.

Livestock Investigations

With the recent movement toward crop diversification and reduction, soil conservation and improvement of soil fertility, livestock studies go hand in hand with the new era in agriculture, and this fact is justification for the adoption of a well-balanced livestock program for the future farming interests of the South and Southwest. The utilization of livestock for the Blackland region of the state has been made an integral part of the practical land use and well-rounded agricultural program for this station.

Sheep: During 1938 a small flock of sheep was purchased by the station for experiments in feeding and breeding. Receipts from sale of lambs and wool in 1939 showed a good margin of profit over maintenance costs, allowing prices above market quotations on feed. Two Dorset rams were purchased and one Romney ram was borrowed from College Station for the purpose of continuing the breeding studies.

Cattle: On October 17, 1938, 20 head of good choice grade Hereford steer calves were purchased for the purpose of utilizing the surplus feed grown on station land. These calves were put on feed November 14, 1938, and fattened for sale in the spring. Allowing very liberal prices for the station-grown feed and grain, this feeding project showed a good net profit after a feeding period of 210 days.

Hogs: A hog feeding experiment was started in October, 1938, with the purchase of 90 head of pigs, which were fattened on the surplus corn, grain, and miscellaneous feed grown on the station. Allowing above market prices for feed, this project ended with a very satisfactory net profit.

Poultry: In the spring of 1939 a total of 300 baby chicks were purchased to be raised on the station for egg production and feeding tests. This project is already showing satisfactory returns, and will be continued through the next year.

C. H. McDowell.

SUBSTATION NO. 6, DENTON

This station is located five and one-half miles northwest of Denton in Denton county. It is representative of the Grand Prairie Region of north central Texas, a region characterized by a rolling topography and dark heavy soils of the San Saba and Denton Series. This region is especially suitable for small grain production, although corn, cotton, and grain sorghums are important crops. The average annual rainfall for the period 1913 to 1939 inclusive is 32.25 inches, of which 25.75 is estimated as the average annual rainfall effective for growing crops. Average effective seasonal rainfall is 7.92 inches for the months of April, May, June; 5.61 inches for July, August, September; and 6.46 inches for September, October, November. The average length of growing season is 233 days with last killing frost November 13 and first killing frost March 25.

A large part of the work of this station is devoted to the breeding and improvement of small grains for the wheat, oat and barley growing regions of Texas. However, considerable time and effort are devoted to the growing and improvement of other field crops adapted to north Texas conditions and to experiments with pasture and soil improvement crops.

Small Grain Investigations

(In cooperation with the Bureau of Plant Industry, U. S. D. A.)

The small grain work at this station consists of extensive breeding work with wheat, oats, and barley; and a small amount of work with flax. Problems of major importance in connection with these crops consist of breeding for resistance to plant diseases, particularly the rusts and smuts. Additional projects include development of varieties resistant to shattering, lodging, drought, and low temperatures. Improved quality for pastry or for bread flour are objectives in the wheat project.

The 1938-39 growing season was generally favorable for the production of small grains, other than spring sown oats, in spite of the fact that germination was very late in the fall of 1938. Fall sown small grains were planted under very unfavorable conditions in the fall of 1938. Subnormal precipitation from July to November made preparation of seedbeds very difficult and the crop was planted in dry cloddy soil. Following emergence about November 15, the crop again encountered drought so that stands were reduced to some extent during the period of November 15 to December 20. Weather conditions during the remainder of the season were favorable for fall sown small grains. A minimum temperature of 16° F. on February 21, as the spring oats were emerging, caused serious reductions in stands and differential killing of varieties. As a result it was impossible to obtain yield data for the spring oats nursery, and yield data in the field plat were influenced by this factor. Precipitation received during the spring months was adequate for all crops except spring sown oats. This crop, having obtained a rather late start and then retarded to some extent by rather cool spring temperatures, was rather late in maturing and encountered insufficient moisture when making its maximum growth and maturing the grain. Yields of fall sown wheat, oats, and barley were very good and quality of grain was among the best ever obtained.

The major diseases of small grain, leaf and stem rust of wheat and oats were minor factors in yield this year. Leaf rust of wheat appeared early in March but due to cool weather and unfavorable moisture conditions, it spread very slowly. Stem rust appeared in the county on April 19, the earliest on record, but never gained headway. Crown rust of oats appeared on April 14, also one of the earliest dates on record, but spread very little. Stem rust of oats appeared very late in the season and only infected late maturing strains in the spring sown nursery. Loose smut of wheat was prevalent in serious proportions in wheat fields of the county again this season.

Wheat: Twenty-one varieties and strains of hard and soft winter wheat were tested in replicated field plats, the leading varieties in yield being Oro x Tenmarq C. I. 11673, Denton x Kanred Selection 4-33-28, Chiefkan, and Kawvale x Tenmarq C. I. 11953. Over a 10 year period the leading varieties are Tenmarq, average yield 30.0 bushels; and Quivira, average yield 32.0 bushels per acre; although the Oro x Tenmarq C. I. 11673 strain has outyielded the above varieties during the past two years. Clarkan, with a 6 year average yield of 27.6 bushels, continues to be the leading soft winter wheat variety.

Two main breeding nurseries were grown. In the advanced nursery 97 varieties and strains were grown in quadruplicate 3 row nursery plats. Included in this test were standard and commercial varieties, 30 varieties grown in regional tests for the U. S. D. A. and known as the uniform yield nursery, and many new disease resistant strains developed at this and other stations. The preliminary nursery consisted of 141 strains in quadruplicate 3 row 8 foot nursery plats. The majority of these strains were hybrid strains developed at this station.

Breeding work to combine leaf and stem rust resistance into the new Hope x Mediterranean commercial back crosses made satisfactory progress. More than 1,700 plant rows from rust resistant selected F_2 material of 1938 were grown and further selections from the F_3 were made this season. Some very promising material both from disease resistance standpoint and the agronomic standpoint have appeared in these crosses.

In cooperation with other stations, a uniform regional bunt nursery was grown studying the resistance of wheat varieties to bunt. Martin x Tenmarq C. I. 11503, developed at this station, continues to rank high in resistance to bunt and in field plat tests has yielded equal to Tenmarq. Variety studies of loose smut resistance were continued this season on more than 80 varieties and strains. Kawvale is the most resistant of the adapted commercial varieties. A breeding program to transfer resistance to loose smut to commercial varieties and desirable new strains is under way.

Fall and spring sown regional U. S. D. A. rust nurseries were grown in the study of the spread and occurrence of physiologic races of rust. The development of rust in this area is of special interest and importance because of the spread of early inoculum from this area to larger wheat growing sections to the north. Partial control of leaf rust and an increased yield of 5.16 bushels per acre were obtained this season on a very susceptible variety of wheat by dusting with sulfur twice weekly. Since it was necessary to dust from the latter part of March on until maturity, the practice would not be practical under the environmental conditions in this section.

Other technical studies under way include a study of the influence of awns on wheat yields in three locations in Texas. Awned segregates yield more than awnless segregates of a cross at Denton, Chillicothe, and

Amarillo, Texas. The increase is greater in the western part of the state. Studies of strength of straw and lodging were continued with the growing of a large hybrid population. Another study involving inheritance of shattering was continued. Data from this season and previous data are being compiled.

A cooperative soft wheat variety test conducted at the U. S. Cotton Field Station, Greenville, Texas again demonstrated that a good quality soft wheat flour can be produced in that area. Cakes and cookies baked from wheat grown at Greenville compared well with that of commercial pastry flour. Denton and Clarkan are the leading soft winter wheat varieties in that test.

Oats: Eleven varieties of oats were grown in field plats from both fall and spring seeding. Leading varieties for a period of years are New Nortex and Texas Red Rustproof 1415-12. Recently a new smut and crown rust resistant Fulghum type strain, Fulghum x Victoria C. I. 3531, has been promising for its disease resistance, yield, and ability to remain standing after maturity. It may be distributed next season to those farmers desiring an oat suitable for combine harvesting. Nortex x Victoria C. I. 3535, a new rust and smut resistant Texas Red Rustproof type has also been promising the past two seasons. From fall seeding New Nortex has averaged 79.5 bushels per acre during the past ten years, with 3 crops lost from winter killing but not included in the average. During the same period, New Nortex has averaged 75 bushels per acre from spring seeding.

Forty varieties and strains were seeded in the advanced oat nursery from both fall and spring seeding. The spring sown test was lost because of freeze damage February 21. Standard varieties were compared with new strains of hybrid origin developed at this and other stations. Twenty-two strains were seeded in the fall sown preliminary nursery and more than 80 strains in the spring sown nursery. Nearly all of these were of hybrid origin.

Breeding work and testing of new strains to secure strains resistant to both rusts and smuts of oats, continues. Good progress was made this season in the selection of stem rust resistant material, as stem rust was prevalent in the late maturing hybrids from spring seeding.

A varietal survey of all red oats was continued this season in an attempt to find strains resistant to lodging after maturity and thus suitable for combine harvesting.

Regional U. S. D. A. uniform rust and smut nurseries were grown as usual. Considerable material developed at this station was tested for smut resistance. Regional uniform winter hardiness nurseries were continued this season, although no winter killing resulted.

Barley: Eleven varieties and strains of barley were grown in the field plat test. Wintex was again the leading variety in yield. This new variety

was also tested at 5 other stations in Texas, at Woodward, Oklahoma, and Stoneville, Mississippi. It ranked either first or second in yield at every station. More than 600 bushels of seed were distributed to farmers this season for growing in 1940. The smooth awn strains Harlan Hybrid 1-33-7 and 1-33-179 produced good yields at many of the same stations but are not quite as productive as Wintex.

Forty strains were grown in the advanced nursery and an equal number in the preliminary nursery. Most of these strains were of hybrid origin, developed at this station. The study of winter hardiness of barley varieties was continued with the uniform set of 50 varieties. No winter killing occurred. A spring sown barley nursery of 22 varieties was grown comparing Wintex and other local strains with the better spring barleys.

Breeding work is now under way to transfer smooth awns and more disease resistance to the high producing Wintex. The second generation of several crosses was grown this year. New crosses of Wintex x Harlan Hybrid 1-33-7 and Wintex x Missouri Early Beardless will be available next year.

Flax: Seven varieties of flax were planted on March 24 in replicated nursery plats. Due to the late planting and dry weather, rather poor yields were obtained. The best yields, over a period of years, have been obtained from North Dakota 113, Linota and Bison varieties planted about March 15. Average yields for this optimum planting date are about 12.0 bushels per acre. A winter hardiness test of flax sown in November showed only one variety, Roman Winter, to have any great resistance to cold.

I. M. Atkins.

Corn Varieties and Hybrids

This year 60 northern produced commercial hybrids were planted in comparison with 33 Texas produced top crosses and 15 common commercial varieties. The average yields for the three groups were 34.4, 34.9 and 28.6 bushels, respectively. Many of the northern hybrids yielded significantly higher than the best common commercial varieties, and several were equal to the best Texas top crosses. In general, the Corn-belt hybrids were from 5 to 10 days earlier in maturing than the Texas hybrids and varieties and, consequently, were not so severely damaged by the extreme dry weather in July and early August.

Double thick planting (2 plants 3 feet apart in 3-foot rows) resulted in a loss of 4.5% in common commercial varieties and a gain of 2.0 and 5.7% in Texas top crosses and Corn-belt hybrids, respectively. It is evident this year that the Corn-belt hybrids withstood closer spacing than native Texas varieties, but additional experiments will be necessary to confirm this.

On the basis of a 12-year test, the leading native Texas varieties are Surcropper, Reese Drouth Resister, Multisure, Yellow Surcropper, Denco Yellow Dent, Skiles' Yellow Dent and Blankenmyer White Dent.

Corn Breeding: In order to improve the color, resistance to smut and other desirable characters in Yellow Surcopper, 72 selected selfed strains were planted in an isolated crossing block, where at the proper time they were detasseled to permit crossing with pre-selected open pollinated Yellow Surcopper planted in every 3rd row. From these 72 top crossed inbred strains, 24 are saved for planting in an isolated block the following year, when additional information on the characters desired is obtained. This process of improvement has been in progress 3 years and has resulted in considerable improvement in color of Yellow Surcopper.

Corn Versus Grain Sorghums

This test was started in 1928 in order to determine the relative value and production of the commonly grown grain sorghum varieties as compared with the most productive variety of corn. During the period 1928 to 1939 the average yield of grain in bushels per acre was 25.5 for corn, 35.3 for Chiltex, 33.2 for Darso, 27.4 for Ajax and 25.3 for Hegari. The low yield of Hegari is due to the fact that it was the only variety that failed to head and make some grain in the extremely dry summer of 1936.

In forage production for the period 1932 to 1939, Hegari, Darso, Ajax and Chiltex made yields of 4.08, 3.66, 3.31, and 3.15 tons dry forage per acre, respectively.

Because of the slightly higher production of grain and the value of the forage produced by the grain sorghums, the livestock farmer in north Texas should make greater use of grain sorghums for feed. When properly handled in rotation with other crops, such as cotton, the grain sorghums are not "hard on the land."

Effect of Grain Sorghum and Corn upon Succeeding Crops: Since 1933 a study has been made of the influence of sorghum varieties and corn on the yield of oats, wheat, barley, corn, cotton and cowpeas. The entire stalk of corn and the stubble of the sorghum varieties are plowed under about September 1 and the above named crops planted at their normal dates. In general, the average yields indicate that the deleterious effect of the grain sorghums does not last longer than about June 1 of the following year. Apparently the duration of the effect depends upon soil moisture and temperature conditions and the activity of micro-organisms, which break down the sorghum residue in the soil. Fall planted wheat and barley and spring planted oats are reduced in yield from 10 to 15 per cent, whereas, corn is affected very little and cotton and cowpeas are not damaged at all. This experiment is important to farmers in that it is clearly shown that they need only to plow under their sorghum residue as early in the fall as possible and then follow with such late spring crops as cotton, sorghum, cowpeas, etc.

Influence of Previous Crop on Yield of Wheat: Grain sorghum stubble in 3-foot rows was planted to wheat without any previous preparation

except leveling the beds with a spring tooth harrow. The yield of wheat immediately above the stubble row was 14.1 as compared with 15.4 bushels for wheat midway between the stubble rows. The yields of wheat on the corn stubble, cotton stubble and from early, medium and late planted cowpea stubble were 25.9, 22.2, 28.6, 28.6, and 28.1 bushels per acre, respectively. This experiment indicates that there is little difference in yield when wheat follows corn or cotton, but the yield is materially increased when following cowpeas and seriously reduced when following sorghum.

Double Cropping with Early Grain Sorghums

The object of this experiment is to determine the amount of side-branching or tillering that may occur after early maturing sorghums are cut for either grain or forage. Quadroon and Sooner milo were planted at early and medium dates in plats that could be harvested by cutting the heads in the usual manner, cutting the heads at the upper node, cutting the heads to include the top 3 to 5 leaves, and by cutting the entire stalk and head as would be done with a row binder. Because of very dry weather in July and August sucker or tiller growth following harvest of the first growth was not sufficient to yield any information on the different methods of harvesting the first crop. This experiment will be continued.

Cotton

Very dry, hot weather in July and August caused premature opening of all cotton varieties, reduced size of boll and length of staple, and slightly increased lint per cent. The average yields from six replications of each of the 36 varieties in the test this year show Bryant Mebane at the top with a yield of 285 pounds lint per acre. Next in order of their yields were Sunshine Selection 55-5, Sunshine Sel. 83-3, Sunshine Sel. 48-1, Sunshine Sel. 128-1, Sunshine Sel. 54-2, Sunshine Sel. 137-5, Hurley Special, Watson and Mebane (A. D.), with 266, 264, 259, 252, 246, 244, 240, and 232 pounds lint per acre, respectively.

For the 10 year period 1930 to 1939, the leading varieties are Sunshine Sel. 83-3, Sunshine Sel. 74-2, Half & Half, Watson, Bryant Mebane, Cliett Sunshine Sel. 54-2, Ferguson 406, and Rogers Acala, with comparable average yields of 281, 280, 279, 275, 272, 268, 266, 264, and 260 pounds lint per acre, respectively.

Cotton Breeding: Twenty-four inbred lines of Sunshine cotton, T. S. No. 10104, were planted again this year for the purpose of studying the effect of inbreeding on the general uniformity of plant characters, staple length and yield. From this breeding work have come two exceptionally good strains, selections 74-2 and 83-3, both of which are in the lead in the regular variety test as well as in this breeding test over a period of five years. In addition to superior yield, both are superior in storm resistance and lint per cent to the parent Sunshine from which they were first selected

in 1929. Both have been increased, and a small amount of seed is now available for distribution to farmers.

Wide Row Spacing of Cotton: Cotton planted in rows 3 feet, 4½ feet and 6 feet apart and thinned to equal number of plants per acre yielded 174, 165 and 197 pounds lint per acre, respectively. For the two year period 1938-39 the average yields are 194, 192 and 214 pounds lint per acre respectively. Since this is only the second year of this test and both seasons have been unusually dry, further tests will be conducted.

Legumes

Since many legumes previously tested were not worthy of further trial, the variety test this year included only those varieties which have shown considerable promise for forage, pasture or soil improvement. For fall planting and use for pasture and soil improvement only the bur clovers, Black Medic and alfalfa have given satisfactory results. The bur clovers are very satisfactory for pasture and soil improvement because they can be seeded in unprepared cotton or corn stalk land early in the fall, will not winter kill easily, will furnish considerable pasture in mid-winter and early spring, and will mature some seed by April 20 when they can be plowed under as green manure and immediately followed by another crop, such as cotton. Hairy vetch and Austrian Winter peas will withstand average winter freezes and are fairly satisfactory for hay or soil improvement; however, these legumes make very slow growth during the winter, furnish very little pasture, and ordinarily do not produce seed sufficient for harvest or to insure a good volunteer stand.

Sweet clover is the outstanding legume for spring planting and for general purpose use on the black upland of this region. A biennial yellow bloom variety, named "Madrid," is superior to all other biennial varieties for hay, pasture or soil improvement. Hubam, the annual white variety, cannot be fall planted in this area and, when planted in the spring, does not yield as well as the biennial varieties. Since Hubam matures considerably earlier than the biennials, it should be used on land infected with cotton root rot disease.

Alfalfa is about equal to sweet clover in forage production during the first two or three years of growth; after this time subsoil moisture is so depleted that the plants cannot make satisfactory growth on the moisture provided by annual rainfall. The Common variety of alfalfa has proved more productive than other varieties tested.

Sweet Clover Method of Planting: Sweet clover planted in 18 inch or 36 inch rows alone or with oats as a nurse crop has been more satisfactory, particularly in dry years, than when planted broadcast or with a grain drill. Planting alone in 36 inch rows is recommended for thin, drouthy-natured soils and when grazing and soil improvement are most desired. When sweet clover is planted in spring oats by any of the above methods,

the yield of oats is slightly reduced and the sweet clover does not make sufficient growth following harvest of the oats to be cut for hay but is valuable for late fall pasture or for turning under as green manure. Second year growth is about the same as that not planted in oats as a nurse crop.

Soy Beans

Mammoth Yellow, Laredo and Ootootan have been in tests at this station each year since 1923, but since 1936 from 15 to 18 varieties have been included. The leading varieties in forage production for the past four years are, Laredo, Ootootan, Delnoshat, Mammoth Yellow and Palmetto with yields of .95, .88, .86, .85 and .85 tons dry forage per acre, respectively. The Laredo variety is to be preferred because it is less palatable to rabbits and produces a high quality forage.

Seed Production: No variety in the test has produced satisfactory yields of seed, probably because of the high temperatures that prevail during the blooming period in July and August. Only four of the 15 varieties in the test this year produced seed. They were, Manchu, Macoupin, Arksoy, and Mamredo with yields of 525, 513, 257 and 102 pounds per acre, respectively. Only Manchu, a very early maturing variety, produced seed in each of the four years of the test. Macoupin and Arksoy, in the test for the first time this year, yielded .99 and .83 tons dry forage per acre, respectively.

Date of Planting: All varieties were planted at three different dates in the spring; the early date about March 20; medium date April 20; and the late date May 20. The average yield of all varieties was .92 tons forage at the early date, .77 at the medium date, and .75 at the late date. Seed production was best at the early date.

Crop Rotation Studies

The influence of 10 different types of crop rotation on the production of cotton as compared with cotton grown continuously on the same land has been recorded each year since 1931. While the average yields of cotton in the different rotations are not significantly different, they do indicate that rotation increases yield. Rotations in which cowpeas or sweet clover are grown as an annual crop for hay and then plowed under have made the highest yields of cotton. However, the use of sweet clover or cowpeas in the rotation has a tendency to increase cotton root rot infection in the soil unless two or more years of non-susceptible crops, such as corn and small grains, intervene between the susceptible crops. Winter legumes, such as Austrian Winter peas and Hairy vetch, have proved fairly satisfactory when planted in corn early in the fall and then were plowed under the next spring in time to prepare the ground for cotton. Rotation of cotton with corn or small grains is a common practice in this North Texas area, and the experiments thus far do not suggest a more profitable practice.

Corn Rotations: Corn also is grown in 10 different crop rotations in comparison with corn grown continuously on the same land. Production

has not been greatly influenced by the type of rotation. Rotations, in which winter peas, vetch or oats were planted in the early fall and then were plowed under as green manure in time to plant corn, have increased the yield of corn slightly. Also, rotations in which sweet clover or cowpeas were planted as annual crops for forage and soil improvement have increased the yield of corn slightly. Other types of rotation have had little or no influence on yields of corn.

Wheat Rotations: For the period 1931 to 1939 wheat in a four year rotation with corn, oats and sweet clover has averaged 26.2 bushels per acre, as compared with 24.3 bushels for wheat grown continuously on the same land.

Oats Rotations: The average yield of oats in four different rotations during the period 1931 to 1939 ranged from 61.5 to 66.6 bushels, as compared with 55.0 for oats grown continuously on the same land. Planting sweet clover in oats in two of the rotations has reduced the yield of oats slightly below that of oats without interplanted clover. However, this method of planting sweet clover does not affect the vigor of the second year growth and is, therefore, an economical method of using sweet clover in the rotation.

Pasture Experiments

Buffalo and Bermuda appear to be the only grasses suitable for establishing permanent grass pasture on the black uplands of this area. Buffalo is the predominant grass in all native grass pastures in this region and is preferable to Bermuda for establishing new permanent pasture. Experiments in methods, rates and time of seeding Buffalo grass are being conducted. Buffalo grass seed planted at the rate of 40 pounds per acre with an ordinary grain drill proved a poor method of seeding because the slow growing seedlings could not compete with other grasses and weeds. Plantings made in 18 inch rows and 36 inch rows and cultivated made very satisfactory growth. Satisfactory stands were secured when planted at the rate of 20 pounds in 3 foot rows and 30 pounds in 18 inch rows. The best time for planting appears to be from March 1 to 20. Pre-soaking Buffalo seed from two to five days before planting hastened and increased germination slightly. Grinding the seed sufficiently to break the bur lowered germination.

Wooly Finger, Blue Grama, Side Oats Grama and Little Blue Stem plats started by sodding made fair growth in both 1938 and 1939. These grasses show some promise for establishing grass pasture or meadow on abandoned cultivated land. Angleton grass was killed by dry weather in July and August of this year and by winter killing in 1938. St. Lucie grass made fair growth during the late spring months but was severely injured by dry weather in the late summer. Rescue and Italian Rye grass have given good results when planted alone on cultivated land and when planted in native grass pasture for late winter and early spring grazing.

P. B. Dunkle.

SUBSTATION NO. 7, SPUR, TEXAS

Substation No. 7, Spur, is located one mile west of Spur, Dickens county, latitude 33 degrees north, longitude 100 degrees west, at an elevation of 2,274 feet above sea level. Spur is located on the Rolling Plains of Texas, being 14 miles east of the escarpment known as the Cap Rock, which forms the line of division between the High Plains and the Rolling Plains of West Texas. The average annual rainfall for 29 years is 20.78 inches with extremes of 11.09 inches and 38.08 inches. The average length of growing season is 214 days. The station comprises 413.7 acres, of which 380 acres are in cultivation and the remainder in native grass pastures. The soils consist of Abilene and Miles clay loams and are characteristic of a large portion of the soils of Northwest Texas.

The station is concerned with three principal lines of research: The development of profitable crop farming under conditions existing in the region; the utilization of feed crops grown in the section in the fattening of cattle and sheep; and complete conservation and utilization of rainfall, including storm water from rough areas, in the production of cultivated and native plants.

Seasonal conditions were highly unfavorable for crop production in 1939. The rainfall was 13.06 inches, or 7.72 inches below normal. At the optimum planting time the soil moisture on the greater part of the station was at or below the wilting point to a depth of 5 feet. Small showers that came later in the season were insufficient to provide the moisture needed to obtain good stands of crops. As a result, stands of only 5 to 10 per cent were obtained in the agronomic experiments, which included cotton varieties, sorghum varieties, etc., and no data are presented for these experiments for this year. A summarization of the results was given in the Annual Report for 1938.

Soil and Water Conservation Studies

(In cooperation with Soil Conservation Service, U. S. D. A.)

The results of the experiments at this station are applicable particularly to the Southern Great Plains Area. This project has been under way for 14 years and has for its purpose a study of the factors influencing run-off losses and soil erosion and the effect of water and soil conservation practices on crop production. The factors contributing to run-off and soil losses are studied on control plats 1/75 acre in area. The efficiency of various terracing systems and other obstructions and of different crops in preventing water and soil losses is studied on field areas varying in size from 6 to 120 acres.

Rainfall: The average rainfall for the 14 years covered by these experiments varies from the 29-year mean by only .67 inch. The amount and distribution of rainfall has therefore been fairly characteristic of that which may be expected over a long period of years. The extremes of yearly

rainfall for the 14-year period have been 38.08 inches in 1926 and 12.88 inches in 1934. The year 1939 was characterized by widely scattered small showers, high temperatures, and low humidity. Very little of the rainfall was effective for crops. Only 69 per cent of the rainfall for the year occurred during the growing season as compared with 79 per cent for the 14-year period. Despite the fact that the yearly rainfall was low and that most of the rains were small, there were several rains of a torrential nature that caused run-off. Rains of this kind are of common occurrence in the region, and it is mainly to prevent water losses from these rains that water conservation measures are needed.

Control Plats: In 1939 run-off occurred during the month of January for the first time since the test was begun. The water and soil loss was small, however, and occurred only on the fallow plats. Total run-off losses as a whole were small as compared with other years, the highest having been recorded on October 8 from the heaviest rain of the year, 2.62 inches. This rain was 43 per cent torrential (.75 inch or more per hour), and an average of 22 per cent of the water was lost from the 8 control plats. Over a period of years the relation of vegetative cover and the physical condition of the soil in reducing water and soil losses is indicated by the following treatments given in order of their effectiveness: Buffalo grass, milo, cotton, cultivated fallow, uncultivated fallow. The effect of slope on run-off from plats planted to cotton is shown by the following average annual losses: level, 1.30 inches; 1 per cent slope, 3.00 inches; 2 per cent slope, 3.09 inches.

Field Areas: The different conservation practices as put into effect on areas of 6 to 10 acres in size show that crop yields have been increased as the amount of water available for plant use was increased. To make use of the soil as a storage place for water that may be later used in crop production is an idea that is rapidly gaining favor in the region and is being put into practice on a large scale. In order to produce maximum crops it is necessary to conserve preseasonal rainfall to supplement rainfall that occurs during the crop season.

The soils of the region, in general, are of such nature that they can absorb and hold within the root zone of cultivated and pasture plants all of the water that falls at any one rain period. In order to retard surface movement of water and to allow ample time for penetration it is usually necessary to use some kind of obstruction on the land.

The following data from field areas of 6 to 10 acres in size give the successive steps taken in water conservation at this station and the effectiveness of these measures in reducing water losses and increasing crop yields:

Treatment	Inches water lost	Inches water added	Yield, lbs. lint cotton per acre
Rows running with slope.....	1.38	.....	116
Rows on contour.....	.60	.....	141
Level terraces, ends closed.....	0	.....	164
Level terraces, ends closed, waste water added....	0	3.10	179

Syrup Pan Terrace System: For 9 years the run-off from a 1,200-acre watershed has been diverted onto a 120-acre tract of cultivated land that has a system of level terraces with alternate ends partly open for conducting the water back and forth across the field as it flows toward the lower end. On account of the low rainfall no water flowed into the system this year. During the past 8 years, however, the amount of water available for crop production has been increased approximately 17 per cent above the normal rainfall. Even in years when heavy flows of water have occurred the damage to growing crops has been negligible. The success of this system indicates the feasibility and effectiveness of using level terraces not only to hold the water that falls on the land but also to distribute additional amounts that have been diverted from other sources.

Pasture Improvement Studies: The results of applying water conservation practices to pasture land compare favorably with those obtained from crop land. Pastures that have become almost bare of vegetation during the drouth years have been restored to a high state of productivity by contour listing and by careful management. The vegetation on the pasture land used in these experiments consisted primarily of buffalo grass (*Buchloe dactyloides*). The following data represent yields of grass obtained from land with 1 to 3 per cent slope that was contour listed at intervals of 39 inches to a depth of 3 inches:

Treatment	Yield, lbs., air-dry vegetation per acre					
	1935	1936	1937	1938	1939	Average
Unlisted.....	858	592	259	810	45	513
Contour listed 1934.....	2424	2315	1133	1376	425	1535
Contour listed 1936.....	.....	1325	2159	1973	448	1476
Contour listed 1938.....	.....	.....	.....	1178	707	942

Attempts to revegetate abandoned cultivated land by seeding with native grasses have proved to be unsuccessful.

Numerous native and introduced grasses, including 88 selections of buffalo grass, are under observation in the grass nursery. Those selections which show promise of being of value in the region were planted in increase blocks for further observation.

Clipping studies of buffalo and blue grama grass show in general that the highest yields and largest amounts of nutrients were obtained from clippings made at intervals of eight weeks or less.

R. E. Dickson, B. C. Langley, and C. E. Fisher.

Vitamin A Requirements for Beef Cattle and Sheep

(In cooperation with the Divisions of Range Animal Husbandry, Chemistry, Veterinary Science and the Bureau of Animal Industry, U. S. D. A.)

In this experiment, which comprised the fifth in the series, 50 head of 464-pound Hereford steer calves were depleted by feeding a vitamin A deficient ration composed of 3 per cent tankage (60 per cent protein), 10 per cent cottonseed meal and 87 per cent cottonseed hulls plus .10 pound of limestone flour per head daily. They were fed as a group until depletion (indicated by night blindness), when each animal was placed in an individual pen and fed dehydrated alfalfa leaf meal to supply 800 micrograms of carotene per hundred pounds of body weight daily until 45 were depleted. At that time the remaining 5 were placed in their individual pens and all were started on a fattening ration composed of 3 per cent tankage, 15 per cent cottonseed meal, 30 per cent ground threshed sorghum grain and 52 per cent cottonseed hulls plus .10 pound of limestone flour per head daily. The five undepleted steers and the five lowest gaining steers of the 50 head were not used in the main grouping but were used as extras, 2 on each level, so that 5 test groups of 8 steers each were used. The 9 depleted individuals in each group were fed dehydrated alfalfa leaf meal to supply 800, 1000, 1250, 1500 and 2500 micrograms of carotene per hundred pounds body weight daily beginning at the same time as the fattening ration, but the undepleted animal in each group did not receive alfalfa until he became depleted. The fattening period was 140 days in length and the grain in the ration contained enough carotene to add about 50 micrograms per hundred pounds body weight to that supplied in alfalfa. The average carotene levels fed in alfalfa and grain were 836, 1,034, 1,286, 1,508 and 2,485 micrograms daily per hundred pounds body weight for the 140-day period.

The mean gains per head for the 5 carotene levels were 202.6, 240.5, 248.25, 253.25 and 250.12 pounds respectively. Statistical analysis of the data revealed no significant difference among the gains except between groups 1 and 3, 1 and 4, and 1 and 5 since a mean difference of 44 pounds was required to be significant.

With the exception of 2 steers, all of the animals on the 4 lower levels were completely night blind at the close of the test. Three steers on the low level became completely day blind. The general tendency in night vision of the animals on the high level was toward greater impairment as time went on, but only 2 of the 9 individuals were completely night blind at the end. Only one, however, was normal in night vision.

Convulsions were noted in all of the 3 lower levels. In Group 1, 6 individuals were observed in convulsions a total of 22 times of which 11 were for one steer. Five animals in Group 2 were noted in convulsions one time each.

Generally speaking, the animals on the 800 microgram level were much more sluggish than those fed the higher levels and were considerably

harder to keep on feed. Their feed consumption was also somewhat less than that of the other groups. Swelling of the hocks was noted in all groups but was not so prevalent in Group 5 as in the others.

Cottonseed Meal in Rations of Ground Milo Heads and Silage for Fattening Steers

With a supply of low priced milo heads and silage in the fall of 1938, and with cottonseed meal relatively high in price, questions reoccurred in regard to the amounts of cottonseed meal which should be fed for fattening livestock.

Three lots of 800-pound steers were fed none, 2.5 and 5.0 pounds of cottonseed meal per head in addition to a full feed of ground milo heads and sumac silage. In this feeding trial the mid-amount of cottonseed meal (2.5 lbs.) was the most practicable amount to feed, for it produced a very satisfactory gain at low cost and the steers attained high finish in 144 days. The cattle fed no cottonseed meal made satisfactory gain at low cost but lacked somewhat in finish and were rough in coat. The larger amount of cottonseed meal (5 lbs.) produced only slightly greater gains than 2.5 pounds and at greater cost.

Limited and Deferred Feeding of Grain with Rations of Cottonseed Meal and Silage

Previous work has shown that yearling steers can be well fattened in about 200 days on rations of silage and 5 to 6 pounds of cottonseed meal without the use of grain. This method of feeding affords a means of disposing of large amounts of silage and has definite possibilities for profit when grains are scarce and high in price and silage is abundant and cheap. It has the disadvantage of producing only moderate gains, because it is impossible for cattle to consume sufficient silage to secure the nutrients required for making high gains. In West Texas this method of feeding forms a basis from which to work in lean years when little grain is available, and in years when only limited amounts of grain are produced the question arises as to the best method of utilizing it.

Three lots of 700-pound steers were fed the following rations for a period of 200 days:

- Lot 1. Sumac silage, cottonseed meal.
- Lot 2. Sumac silage, cottonseed meal, 7.5 pounds ground milo heads fed during the last half of the feeding period.
- Lot 3. Sumac silage, cottonseed meal, 3.83 pounds ground milo heads fed during the entire feeding period.

The object of the experiment was to determine the value of adding a limited amount of ground milo heads to a ration of sumac silage and cottonseed meal when the milo was fed (a) during the entire feeding period, and (b) only during the last half of the feeding period.

The addition of 3.83 pounds of ground milo heads daily to the ration of silage and cottonseed meal increased the amount of finish but did not increase the gain. The addition of 7.5 pounds of ground milo heads during the last half of the feeding period gave slightly greater gain and finish than cottonseed meal and silage alone, and slightly greater gain but less finish than 3.83 pounds of ground milo heads during the entire feeding period.

J. H. Jones, R. E. Dickson, J. K. Riggs.

SUBSTATION NO. 8, LUBBOCK

Substation No. 8 is located 3 miles east of Lubbock, Lubbock County, which is on the southern tip of the south extension of the High Plains Region. Locally this region is known as the South Plains.

The latitude is 33 degrees and 37 minutes north, longitude 101 degrees and 45 minutes west, and elevation 3,215 feet above sea level.

The average annual rainfall over a period of 29 years was 18.71 inches; with yearly extremes of 8.73 and 31.88 inches. The rainfall for 1939 amounted to 11.71 inches. The Station comprises 160 acres of land, 152 in cultivation and the remainder in farmstead and native pasture. The soil is of the Amarillo and Richfield fine sandy loam type, which is typical of a great portion of the region.

The predominant agricultural crops of this region are sorghums and cotton. The program of work at this Station centers around these two crops under both dry land and pump irrigation conditions.

Grain Sorghum Experiments

Grain Sorghum Varieties: The principal varieties of grain sorghums grown in this region are milo, kafir, and hegari, with an increasing interest in the combine types on account of the economies in harvesting.

Seasonal conditions were considerably below normal resulting in correspondingly low grain yields. Excellent January rains furnished good subsoil moisture, while early May showers provided fair topsoil moisture. The normal planting season usually centers around May 25, but by this time topsoil moisture was rather low. June was extremely dry and hot. Scattered showers in July were ineffective as a whole. A heavy rain of August 4th was the most beneficial of the season, as many sorghums were blooming at this time. The balance of the growing season was hot and dry.

Under the above conditions the average yield of 24 varieties was 12 bushels. Club Kafir led with 19 bushels, followed by Texas Milo, a pythium resistant strain, with 17 bushels. The kafirs as a group averaged 15 bushels, with little difference in yields between the various strains. Hegari yielded 9 bushels. All of the extremely early varieties made a poor showing.

Pythium Resistant Strains of Milo: Efforts to isolate superior yielding strains of dwarf yellow milo resistant to milo blight, *Pythium arrhenomanes*, were continued this year. Nineteen of the more promising strains grown in 1938 were compared with T. S. No. 670, a non-resistant variety. S. A. 5095-7, and 5; T. S. 25243-7, 4, and 15 with yields of 20, 19, 20, 18, 18 bushels per acre were the best this year. The non-resistant strain yielded 14 bushels. The fact that they were grown on land cropped to cotton in 1938 and the lack of rain combined to narrow yields.

On land continuously cropped to milo the non-resistant strain yielded 8 bushels, the resistant 26 bushels.

As in 1938, a distribution this year of 17,000 pounds of seed was made throughout the sorghum belt of Texas with gratifying results.

A resistant strain of Early Yellow or Sooner Milo has been developed and a small distribution will be made to the Certified seed growers for their 1940 crop.

Hegari Strains: Five strains of Hegari grown at different latitudes in the sorghum region were planted at three different dates: May 12, June 1, and July 8 to study their response to length of day and planting date as measured by various characters. Strains received from Arizona; Woodward, Oklahoma; and Chillicothe, Texas showed no significant difference for all three dates. Early Hegari showed a distinct difference in its response from the above mentioned strains, especially on the first two planting dates. There was a pronounced tendency on the last planting to shorten this spread. Undoubtedly the acute shortage of water and high temperatures acted in a modifying capacity.

Sorghum Breeding

Combine Types: A number of promising kafir-milo hybrids were selected in the nursery for field tests. A limited distribution will be made from three selections that have appeared promising under field conditions the past two years.

Hegari-Milo: Two selections with yellow seed and extremely early in maturity will be grown in the strain test again in 1940. Both a white and yellow seeded combine type with 16 leaves will also be added to the above.

Sumac-Kafir: Nursery selections for field testing were made which correspond closely to Dwarf Kafir in height and maturity but with sweet, juicy stalks.

Red Kafir-Hegari: From a number of strains which have been field tested the past three years, two in particular have produced excellent yields of forage and grain and may possibly have a place as a bundle feed. Favorable reports were received from a limited distribution made in 1939. A large number of selections in the F_2 were made for nursery plantings in 1940, which were selected because of various desirable characteristics.

Charcoal Disease, *Sclerotium bataticola*: This disease, which results in severe lodging of the plants at approximate milk stage of the grain, was not nearly as severe this season as in 1938. It appeared to be more prevalent on land continuously cropped to sorghums than on rotated land. None of the irrigated areas were affected this season. No definite progress was made in securing resistant selections.

Cotton Experiments

Cotton Varieties: Thirty-six varieties of cotton were grown in 1939, ranging in staple length from $\frac{7}{8}$ for Hi-bred and Western Prolific to 1 $\frac{1}{16}$ inch for California Acala and Texacala. The average yield of lint for all varieties was 165 pounds. The six highest with yields were:

Variety	Acre	Yield, Lint Pounds
Hi-bred		218
Mebane 141		207
Mebane 140		206
Western Prolific		204
D. & P. L. 11-A.....		190
Rogers Acala No. 111....		189

Seasonal conditions were trying, as only 2.81 inches of rain fell between May 5 and August 1. A good August rain was extremely beneficial. Planters as a whole used varieties having longer fiber than usual this year. As a consequence there will be a return to shorter growths to which this area is much better adapted.

Cotton Breeding: The cotton improvement program at this Station has three objectives: to produce an unusually early maturing strain which can be used in years when late planting is necessary due to various causes; second, a storm-proof cotton for use in mechanical harvesting; and third, a strain to be grown for seed crushing purposes only.

The early maturing strain had 36 per cent of the total crop open when Acala had 17; Mebane, 6; and D. & P. L. 11-A, 11.

It was possible to allow all bolls to open in the storm-proof selection without losing a lock. On account of its short staple length, crosses have been made with longer fibered varieties, and it is hoped selections having both fiber length and storm proofness can be found.

Crosses have been made with a lintless strain of Cleveland which was found on the Station in 1936. It is hoped to secure a segregate that will have sufficient fiber to prevent wasting of the seed so that the crop can be harvested for crushing purposes only.

Cotton Plant Spacing and Fiber Length: This test is to determine the effect of different plant spacings upon yield, and fiber length. Acre yields of lint for three, six, nine, twelve, and eighteen inch plant spacings were 96, 120, 106, 112, and 90 pounds respectively. There was no difference in

staple length this year. No doubt seasonal conditions entered into this factor somewhat as all plants stapled $\frac{7}{8}$ inch in spite of the fact that Acala, a normal 1 to 1 $\frac{1}{16}$ inch cotton, was used.

Pasture Grasses: Sudan grass in broadcast and row plantings was compared with buffalo grass turf under both dry land and irrigation. Row plantings of sudan grass yielded 1.02 tons of air-dry hay per acre under dry land conditions, and under irrigation 2.08 tons. Broadcast plantings under the same conditions yielded 1.01 and 1.72 tons. Buffalo grass turf yielded .9 ton per acre where irrigated, while the non-irrigated yielded .197 ton.

Date and Method of Preparing Seed Bed: The seed bed is prepared during January and April. Two methods and depths were used: plowing and listing, and 3.5 and 7 inches deep.

Results with Grain Sorghums: January prepared ground averaged 19.0 bushels per acre as compared to 16.3 for April. Plowing averaged 18.2 bushels per acre, while listing averaged 17.1. Seven inch prepared seedbed averaged 18.1 bushels per acre as compared to 17.2 for 3.5 inches. Date, method, or depth exerted little influence on production this season.

Results with Cotton: January prepared ground averaged 146 pounds of lint per acre as compared to 140 for April. Plowing averaged 142 pounds, listing 144. Seven inch prepared seed bed averaged 144; three and one-half inches, 142 pounds.

Soil Fertility and Moisture Conservation: Sixty-four 1/10-acre plats are devoted to a study to determine the effect of continuous cropping, fallow, fertilizing with barnyard manure, green manure, and various crop rotations on both crop production and soil moisture. Cotton and grain sorghums are the crops grown, with sorgo used for green manure.

Results with Cotton: This year the average for the 21 plats was 274 pounds of lint per acre. The highest yield was obtained from a 3 year rotation of cotton after fallow after grain sorghum, 438 pounds; the lowest was made from a 2 year rotation, cotton manured alternated with grain sorghum. Cotton continuously cropped for 25 years and barnyard manure applied at the rate of 4000 pounds per acre yielded 159 pounds; where unfertilized, 212 pounds.

Results with Grain Sorghum: 21 plats were cropped to grain sorghum. The three highest plats were as follows:

Grain sorghum manured after fallow after cotton.....	40.3 bu.
Grain sorghum after fallow.....	39.4 bu.
Grain sorghum after fallow after cotton.....	39.4 bu.

Where grain sorghums have been grown continuously for 25 years, the average was 12.3 bushels, as compared to 12.9 bushels where barnyard fertilizer at the rate of 4,000 pounds per acre applied.

Barnyard Fertilizer and Cotton Burs: Plats receiving no fertilizer are compared with those receiving 2, 4, and 8 tons of barnyard fertilizer and two tons of cotton burs per acre. Poor moisture conditions existed throughout the growing season. Acre yields of lint cotton of 163, 165, 170, 134, and 150 pounds were obtained from no fertilizer, 2, 4, and 8 tons of barnyard fertilizer and 2 tons of cotton burs in the order named.

Cotton and Grain Sorghum Under Pump Irrigation: An experiment to determine the total amount of irrigation water necessary to produce maximum yields and its date of application was started in 1936. At set up, the experiment calls for the following treatments: no irrigation; a preplanting irrigation sometime in the early and another in late spring; one preplanting irrigation and one in early summer; one preplanting irrigation and two in summer some three to four weeks apart. All irrigations are to be applied at the rate of three acre inches. The postplanting irrigations are to be applied, as nearly as possible, at the most effective time.

Results with Cotton: Plats receiving no water outside of rainfall averaged 201 pounds per acre as compared to 344 for the one preplanting watering, 466 where two preplanting irrigations were made, 382 with one each of preplanting and postplanting, 406 with one preplanting and two postplanting.

Results with Grain Sorghums: Hegari was the grain sorghum used, and receiving the same treatment as above, the yields in order were: 9.6, 27.2, 39.3, 48.4, and 58.8 bushels per acre.

Fertilization of Cotton Under Irrigation: Plats receiving an application of 8 tons of barnyard manure per acre averaged 1,118 pounds of lint cotton per acre. Non-fertilized plats averaged 870. In addition the fertilized plat was somewhat earlier in maturity. Both treatments received four irrigations each of three acre inches of water.

Alfalfa: Irrigating alfalfa just previous to each cutting returned yields amounting to 7.09 tons per acre of air dry hay. Irrigating just after cutting, instead of just previous, averaged 6.42 tons. The plats used for both methods produced seven cuttings and received 44 inches of irrigation water in addition to 6.98 inches of rainfall.

Corn Varieties: Open pollinated varieties were compared with Corn Belt hybrids under irrigation and dry land conditions. The irrigated plats received four irrigations each, of approximately three acre inches. Excessive June temperatures damaged all corn.

Eight open pollinated varieties averaged 22 bushels per acre under irrigation, the hybrids 25. Under dry land conditions the same varieties averaged 6 and 5 bushels.

Castor Beans: Five varieties of castor beans were grown under both irrigation and dry land conditions. Under dry land conditions Flowering

and U. S. D. A. No. 4 both averaged 546 pounds of clean beans per acre. Under irrigation U. S. D. A. No. 7 led with 1,576 pounds. Shattering was heavy and as a consequence yields would be higher if all beans had been recovered.

Sugar Beet Production: Two dates of planting and three varieties were grown for seed production under irrigation. U. S. No. 12 led with 2,516 pounds of clean seed. The varieties were irrigated 7 times.

Three varieties, U. S. No. 33, No. 30294-0, and old type were grown for beet production. Yields of 23.76, 24.20, and 25.22 tons per acre in the order named were obtained. A total of 11 irrigations were made.

SUBSTATION NO. 9, BALMORHEA

Substation No. 9 is located adjacent to the Old Spanish Trail Highway approximately 4 miles east of Balmorhea. This farming area and surrounding ranching area is served by the Pecos Valley Southern Railway, a branch of the Texas and Pacific Railway. The elevation of the Station is approximately 3,200 feet above sea level. The latitude is about 31 degrees north, and the longitude 103 degrees 41 minutes west. The annual precipitation varies greatly but is never sufficient to produce crops without irrigation. The average precipitation for the past 17 years has been 14.04 inches. During the growing months from March to September inclusive, the rate of evaporation is very high and this high rate of evaporation, together with the low rainfall, make it necessary to use large amounts of irrigation water for crop production. Most of the water for irrigation comes from flowing springs, but this is supplemented by flood water from the Davis Mountains, which is caught and stored in a reservoir known as Balmorhea Lake.

Station work during the past several years has dealt largely with the problems connected with a better balanced agriculture for these irrigated sections and this has included the growing of many varieties of the various kinds of horticultural and agronomic crops and also the development of a system for feeding lambs and cattle in which they could be profitably fattened and finished through the use of large amounts of locally grown roughages and with minimum amounts of concentrates which must be brought in from the outside.

Fattening Steers in the Madera Valley

The steer feeding experiments completed in 1939 continued the study of methods for using large amounts of roughage together with small amounts of concentrate feeds. Six lots of 10 head of yearling steers averaging 707 pounds, were fed on rations containing alfalfa hay and hegari fodder and hegari silage as the roughage. A direct comparison of hegari fodder and hegari silage was made with 0, 2 and 4 pounds per head of alfalfa hay. During the first 112 days of the feeding test the lots that were fed dry fodder made greater gains than those that were fed silage, the other parts

of the rations being the same. However, during the last part of the feeding period the silage lots made greater gains and at the close of the experiment there was very little difference in the average gains and finish of the three lots fed dry fodder and the three lots fed silage. However, there was a slight difference in favor of the dry fodder lots. In the comparison of 0, 2 and 4 pounds respectively of alfalfa per head, the 2 pounds daily made the greatest gains for both dry fodder and for hegari silage. Because of the large quantities of roughages used in these lots, all of these steers returned a good profit above the cost of feeds, the average profit for the 6 lots being \$19.20 per head.

Since large quantities of alfalfa and sorghum roughages may be produced cheaply in these irrigated areas, and there is a shortage of concentrate grain feeds, it is believed that this is the most practical method of feeding cattle.

Agronomic Work

Because soil and climatic conditions here limit the variety of crops which can be successfully grown, the agronomic work of the station has dealt principally with the staple crops adapted to this region. These crops have included cotton, sorghums, small grains, alfalfa and various other legumes and miscellaneous crops.

The better strains of Acala cotton, including Rogers, N. M. College, and Youngs' strains have proven to be most suitable for general planting under irrigation and a "One Variety" cotton community has been established in the valley with the Acala as the standard variety.

Results obtained from use of fertilizers have not been consistent but usually phosphorus has increased yields of alfalfa and nitrogenous fertilizers have increased yields of cotton on lands not recently in alfalfa. Applications of lime, potash, and sulphur have had no noticeable effect on crop yields.

Hegari has been the best standard forage crop for cattle feeding since it produces a medium heavy tonnage of excellent quality. Red Top is the best sweet sorghum and Dwarf Yellow milo the best strictly grain sorghum. However, under irrigation it appears to be more practical to grow hegari and feed the entire plant after grinding rather than to grow D. Y. Milo for grain alone.

Of the large number of legumes which have been tried, none have been able to compete with alfalfa and sweet clover under these conditions.

Fruit Adaptability Trials

Various plantings of fruit and nut trees on the Station have indicated that growing conditions here are not favorable for commercial production of such crops. However, every farm should have a few of the varieties best adapted for home use. These should include peaches, plums, apricots,

pears, and the western varieties of pecans. Pecans should be planted only where they will receive an abundant supply of water.

Vineyards

During the past fifteen years many varieties of grapes have been planted but only a few varieties have been able to survive the unfavorable climatic and soil conditions. Most soils here are infected with the cotton root rot fungus and this has attacked nearly all varieties with the exception of the Champanel, Mustang, and Black Spanish, which appear to have a high degree of resistance. The Rose of Peru and Thompson Seedless have been two of the most promising vinifera varieties.

Ornamental Adaptability Trials

A large amount of ornamental material has been planted on the Station during the past few years in an attempt to determine the adaptability of these varieties to soil and climatic conditions here.

As a group the coniferous evergreens have made a good showing. Among the best of these are the Red Cedar, Arizona Cypress, Pfitzers Juniper, Italian Cypress, Ramsey's Hybrid, and most of the common varieties of arbovitae. Other plants which have done well are the flowering pomegranate, vitex, flowering willow, honeysuckle, live oak, Arizona Ash, Black locust, *ulmus parvifolia*, *euonymus*, and Osage orange. Black walnut has made a fair growth.

Some trees such as the Russian olive, cottonwood, and Chinese elm are well adapted to climatic conditions but are very susceptible to the cotton root rot fungus and losses are heavy.

John J. Bayles.

SUBSTATION NO. 10, FEEDING AND BREEDING STATION

Substation No. 10 is located at College Station, Brazos county, one mile northwest of the College on the public highway; its latitude is 30 degrees north and its longitude 96 degrees west; it is 308 feet above sea-level. The annual average rainfall over a period of 40 years was 38.02 inches. The land owned and assigned to the Feeding and Breeding Station comprises 920.8 acres.

The work of this station embraces investigations in the feeding, breeding, and management of swine, dairy cattle, poultry, goats, and sheep. Progress of work on projects with these animals is treated elsewhere in this report under the respective divisions concerned.

Of the land embraced in this station, approximately 150 acres are in cultivated crops, 200 acres in improved pasture, and the remaining 570.8 acres in native pasture.

SUBSTATION NO. 11, NACOGDOCHES, TEXAS

Substation No. 11 is located one-half mile north of the city limits of Nacogdoches, Nacogdoches County, on State Highway No. 35; its latitude is 32 degrees north and its longitude 94 degrees west; its elevation is 292 feet above sea level. The average annual rainfall over a period of 27 years was 48.46 inches, with a total rainfall of 43.14 inches for the 1939 season. During this period an average of 15.31 inches, or 31.6 per cent of the total average annual rainfall occurred during the months of May, June, July, and August, but this year 9.86 inches, or 22.9 per cent, has fallen during these months. The average length of growing season during a 26-year period is 248 days, with the average last killing frost in the spring occurring March 12, and the average first killing frost in the fall occurring November 15. The purpose of this station is to serve the region of Texas in which the Nacogdoches soils, or "Redlands", occur. The redlands of the Nacogdoches soil series were among the earliest settled farm lands in the state. The soil in the virgin state is productive, but since much of it has been in cultivation for a long time, one of the chief problems of the station is that of finding the most effective and the practicable systems of cropping for building up and maintaining soil fertility; other studies concern the use of fertilizers, including rate and time of application, and the development of horticultural and agronomic crops suited to a diversified agricultural program for this region.

Soil Improvement Investigations

Preliminary Studies of Artificial Plats for Field Experiments: In continuing the studies on the use of concrete tank plats for soil fertility tests Sudan grass was grown again during the 1939 season in 1/1000 acre plats. Nine fertilizer treatments and one soil check were replicated six times in the available sixty plats. Only one cutting of forage was secured on account of prevailing dry weather following the first cutting.

A summary of the yields of dry forage produced by the various treatments shows an increase from their use in every instance over that of the unfertilized areas. The use of the formula 4-8-4 at the rate of 600 pounds per acre produced greater yields than the rates of 200, and 400 pounds. Comparable amounts of 4-8-4 and 4-8-0 fertilizers showed an increase in yield of the 4-8-4 over the 4-8-0 formula. There was a significant increase in the yield of Sudan grass from the use of 6 and 8 per cent of phosphoric acid. The absence of nitrogen from the formula showed this plant food to be more of a limiting factor than either phosphoric acid or potash in the production of Sudan grass hay.

A five-year summary shows a definite and consistent increase in forage production where the amount of a 4-8-4 fertilizer was increased from 200, to 400, to 600 pounds per acre. Potash showed no increase from its use. Consistent increases were obtained from the use of phosphoric from none to 6 to 8 per cent. Nitrogen is apparently the main plant

food required as varying amounts from none to six per cent produced consistent and significant increases of dry forage.

Fertilizer and Seed Treatment Studies

The cooperative project initiated during the 1936 season on the effect of disturbing the seedbed where applying fertilizer at different positions in relation to the cotton seed, and the use of fungicides on cotton seed prior to planting was continued during the year. The results of the study are reported fully in the Division of Agricultural Engineering.

Green Manure Studies

During the fall of 1937 a project was initiated for the study of the comparative value of oats and Hairy vetch when used for green manure purposes preceding cotton. A review of the yields of lint cotton obtained during the 1939 season shows the greatest production to have been derived from the areas that did not have a green manure crop turned under but remained fallow during the winter and received 400 pounds to the acre of a 4-8-4 fertilizer prior to planting the cotton seed. A mixture of oats and Hairy vetch plus 400 pounds to the acre of a 0-8-4 fertilizer applied at the time of planting the green manure crop produced the second high yields. The third high yield of lint was produced by the planting of Hairy vetch plus the fertilizer treatment of 400 pounds to the acre of a 0-8-4 applied prior to planting the vetch. The area receiving no fertilizer or green manure treatment was low yielder for the test again this season. Yields were materially reduced on those areas that had two consecutive crops of green manure, mainly of Hairy vetch, turned under by the early appearance of Fusarium wilt. The disease continued its attack until late June and in some replications the loss of stand was so heavy that results were not obtained on their production.

Records obtained on the amount of green manure turned under showed the largest yield was from the planting of Hairy vetch which received the fertilizer treatment of 400 pounds of a 0-8-4 to the acre prior to being planted. A mixture of oats and Hairy vetch was the third in production of green manure.

Agronomic Crop Investigations

Cotton Varieties: Twenty varieties were grown in the 1939 cotton variety test with six replications of each variety. Hi-Bred made the highest average yield with 290 pounds of lint per acre, 27/32 inch staple, and 41.5 per cent lint; Mebane was second with 222 pounds lint to the acre, 31/32 inch staple, and 39.3 per cent lint; the third most productive was a strain of the Half & Half x Lone Star cross with 203 pounds lint to the acre, 29/32 inch staple, and 41.0 per cent lint; D & P L 12 was the fourth with 202 pounds lint to the acre, with 1-1/32 inch staple, and 37.1 per cent lint; the fifth in production was Texas Special with 199 pounds lint to the acre, 31/32 inch staple, and 39.6 per cent lint.

Cotton Breeding

In a continuation of the cotton breeding work of this station, twenty-four progeny rows of plant selections from the 1938 F₂ progeny rows, and their parents were grown. These selections were from strains of a cross of Half & Half x Lone Star made by D. T. Killough, Cotton Breeder, Division of Agronomy. Within these twenty-four progeny rows, eight were selected for selfing all plants within the row, the remainder had three desirable plants per row selected for further selfing, eight to twelve selfed bolls per plant being secured. Ten individual plants from certain of the progeny rows were harvested separately for further laboratory selection of these inbreds for planting during the 1940 season. A planting for increase during 1940 was made during the season of forty-two progeny rows from individual open-pollinated selected plants from best progeny rows grown during 1939. Ten individual plants from certain progeny rows were selected and harvested for further laboratory analysis as to length, per cent, and yield of staple. One lock samples were taken from each individual plant in all of the above progeny rows for laboratory analysis in order to have a comparative standard for making the field selections.

During the year continued work was done on the backcrossing of the selfed parents Half and Half, and Lone Star to seventeen backcrossed strains in the B/C₄ generation. Five individual plants were selected in each of the rows for use in the backcrossing and to make further selfs of the individual female plants. The necessary data, such as, yield, per cent of lint, and length of staple, was obtained from each of the strains.

A randomized field yield strain test begun during 1935 was continued this season with 36 selected selfed strains of the Half & Half x Lone Star cross, selfed selections of the parent varieties, along with commercial seed of the two parent varieties; (Hi-Bred was used in the place of Half & Half this season). Results this season shows that 4 of the 36 increase strains in the ninth hybrid generation grown in six replications produced higher yields of lint than the most productive parent, Half & Half, or commercial seed of the Hi-Bred. Twelve of the strains had a percentage of lint greater than the high percentage parent, Hi-Bred. Four strains had a length of staple equal to the longer lint parent, Lone Star; and twenty showed to have a length of only 1/32 inch less than the Lone Star parent. The quality of the fiber in the hybrids is not as coarse as the fiber in Half & Half, and tends to approach the finer fibered Lone Star parent. Further selections are being made to obtain high yielding types equal in fiber properties to that of Lone Star.

Selections made from selfed plants grown during the 1938 season of the D. & P. L. 11A, and Greer strains, were used this season in making reciprocal crosses with six of the Half & Half x Lone Star strains. An additional increase block of the D. & P. L. 11A, and Greer strains, was

grown for the purpose of making further selfs of these parent strains, and to secure production records.

Corn Improvement

The work at this station pertaining to the improvement of corn for this section continues the work in the development of a yellow prolific variety. In this connection 50 selfed ears of the Texas Golden Prolific were selected from the 1938 lot and grown in four replications during 1939. These were cross-pollinated by open pollinated ears of the Texas Golden Prolific. A field yield strain test was conducted on 14 of the most productive open pollinated strains grown in four replications during the 1938 season; the strains were also selected for color, type, and other characters having to do with a desired variety.

A total of 167 bushels of State Registered seed of the Texas Golden Prolific was distributed to growers from the increase block grown during the 1938 season for planting during the 1939 season.

Further work is being done in an effort to advance the maturity and to reduce the height of stalk of the Texas Golden Prolific. The crossing and backcrossing work with Yellow Surcropper was continued this season with two plantings of the 7/8 Texas Golden Prolific being made. The selections were from plants having three or more ears, and those with one or two ears. Approximately 500 selfed ears were obtained from these plantings and the number of ears per plant recorded from which selfed ears were secured.

Horticultural Crop Investigations—Variety Studies

The variety test on Rubus at this station has been reduced to eleven varieties. No new varieties were set out during the 1939 season. Of the new varieties placed under observation prior to 1939 none have shown any particularly promising characters over a number of the older varieties which have previously been reported.

Blackberry and Dewberry Breeding

Rubus breeding at this station is being conducted along two lines to introduce high-yielding varieties and strains that are superior in flavor and quality to the existing adapted varieties. At the same time an effort is being made to establish certain desirable vegetative characteristics.

First, a large number of selected varieties have been inbred in order to isolate the factors desired for further crossing. Second, a large number of crosses have been made, with the Young dewberry, Crandall's Early, and Halls Lawton blackberries as pollen parents. These varieties were crossed with a number of other varieties having desired characters and also crossed with each other.

In continuation of the breeding program several hundred self-pollinations were made on a number of varieties and also on a large number of F_1 selfs and hybrids. The inter-varietal crosses were limited this season between the varieties, Young, Crandall's Early, and Hall's Lawton; with no additional backcrosses being made.

During the 1939 season approximately two thousand seedlings were moved to the trial grounds. These seedlings were obtained from the breeding work carried out during the 1938 season. Heavy losses of the planting came as a result of continuous dry weather during a large portion of the growing season. There are approximately forty-five hundred seedlings under observation at the present. A large number of the two-year old seedlings were most promising as to production; however, the desired quality of fruit in combination with favorable production has not been observed in this lot of material.

Adaptability Investigations With Fruit Crops

During the year further material was assembled for the adaptability study of fruit varieties in East Texas. The station orchard consists of 232 varieties and selections of peaches, 15 varieties and selections of plums, and six varieties of pears.

Of the 65 peach varieties producing marketable fruit this season, seventeen showed to be particularly promising. Of the yellow freestone type the varieties (named in order of ripening), June Elberta, Golden Jubilee, Halehaven, Rochester, Elberta, J. H. Hale, Halberta, Rio Oso Gem, and Barbara, were outstanding. The variety Early Rose was perhaps the more promising of the early white clings, although Uneeda continued heavy production of a desirable early fruit for local consumption.

Of the plum varieties, Six Weeks, Methley, America, and Gold were the more productive; with Methley, Bruce, and Gold producing fruit of high quality for fresh eating.

In studying the cold requirements of the peach varieties for normal blooming thermograph records show a total of 161 hours of 32 degrees or less during the 1938-39 season, 394 hours below 37 degrees, 1115 hours below 45 degrees, 1573 hours below 50 degrees, and 2056 hours below 55 degrees. A total of 31 varieties were studied during the season.

Ornamental Adaptation Study

The purpose of this project is to have at this station specimens of both local and foreign plants in order to accumulate ecological data for the local nurserymen and landscape gardeners. A large portion of the material is used in developing the landscape design of the station farmstead. Such material included in the test this year does not have sufficient promise as to merit its being described in detail.

Tung Oil Studies

Due to temperatures of 33 degrees on March 2 no fruit of the Tung was set in this section.

All plantings of Tung, which consisted of fertility studies, and testing of seedlings, being conducted in cooperation with local people were discontinued during the season.

Reforestation Slash Pine Adaption Studies

A cooperative project on the adaptation of Slash pine to the Nacogdoches soils is being conducted with the Texas Forest Service. Growth records obtained during the 1939 season showed an average growth during the first six months of 34.4 inches, and a growth of 3.4 inches average for the 72 trees during the second six-month period. Diameter measurements at the end of the 12-months period showed the nine-year-old trees to have an average of .52 inch increase; the average diameter of these trees is 3.3 inches. The average height of all trees at the end of the season was 18.7 feet with the tallest tree being 24.4 feet.

Post Treatment Studies

During the year a cooperative project with the Texas Extension Forester was started on treating fence posts in various ways in an attempt to utilize small undesirable trees in the woodlot. A number of pines, redoaks, and elms, were first treated with zinc chloride and set aside to cure. These have been labeled and placed in the station fence for further observation.

H. F. Morris.

EAST TEXAS PASTURE INVESTIGATIONS, LUFKIN

The location of this field laboratory is six miles west of Lufkin, Angelina County, on State Highway No. 94. The latitude of the laboratory is 31 degrees north and the longitude is 94 degrees west. Its elevation ranges from 217 to 270 feet, and it covers a total of 228.67 acres. The majority of the land is utilized for grazing and timber production, with less than 20 acres being used for the growth of row crops. There are about 150 acres of unimproved timbered pasture of which most is covered with young pine and hardwoods. Some culling and thinning has been done in practically all of the timber in addition to cutting the underbrush. Goats are helping to keep the sprouts and brush, which result from the cultural methods, partly in check.

The average annual rainfall from 1934 through 1939 is 48.10 inches with extremes of 60.71 inches in 1935 and 38.51 inches in 1936. The total precipitation this year was 48.65 inches. In general, the rainfall is poorly distributed, thus making the total annual figures somewhat misleading. As

an example, the total for this year was 48.65 inches, yet the major part of the rain fell in January, February, November, and December, leaving the growing season, especially the latter part, one of the driest ever recorded. The average length of the growing season is between 250 and 260 days. Until weather recording instruments other than a rain gauge are installed, such information as temperature, atmospheric humidity, evaporation, and wind movement obtained at Substation No. 11, Nacogdoches, will be considered applicable to this location.

A detailed soil survey made on the laboratory's land revealed the following five field-named soils: Angelina very fine sandy loam; Angelina very fine sandy loam, gully phase; Caddo fine sandy loam, deep phase; Ochlockonee fine sandy loam; and Bibb silt loam. These soils are characteristic of a great part of the land in the East Texas Forest Region, and, in general, are identified by a greyish, sandy top soil with a very tight subsoil of approximately the same color. These soils are slightly acid in reaction. From the standpoint of good pastures and livestock, soil fertility is probably the limiting factor; however these soils respond readily to fertilizers and good treatment. Thus it is possible to overcome part of this deficiency.

The shrubby plant coverage, consisting mainly of French or Spanish mulberry, youpon, and wax myrtle, furnishes browse of very little if any value. The native grass coverage, composed largely of the sages and many other coarse, rather tall, bunch-type grasses, is of value for a relatively short period during the year. The nutritive value of these grasses is considered low at all times. There are no sod-forming grasses in the native grass coverage unless Bermuda and carpet are to be considered native.

There are over one million acres of cut-over pine and hardwood forest land in East Texas that are not reproducing timber at present. Very little of this land is being utilized profitably, and a large part of it is classed as "open range," or not fenced. With only a few definite systems of livestock raising being practiced, the average quality of the livestock has been low. Therefore this field laboratory has been doing research work to determine whether better livestock, especially beef cattle, can be produced in the region directly through importing better cattle and indirectly through pasture improvement and good husbandry. The demand for better livestock in the region has grown enormously within the last year with hundreds of head of high-grade and registered animals being shipped in. As a consequence the pastures are being improved and better care is being taken of the livestock.

A total of 2,885 people visited the station this year.

Livestock and Pasture Improvement Investigations

It was reported in the 1937 and 1938 annual reports that the experimental herd of Hereford cattle on the station was attaining normal weight

and size by grazing improved pastures and by being fed during the non-productive stage of the pastures (December, January, and February). How the pastures were improved and details of the feeding are given later in this report. Force feeding of the minerals copper, iron, cobalt, and bonemeal have failed to give sufficient gains on these cattle while they were managed as above. Whether any of these minerals or others are deficient from a biological standpoint on the strictly native pastures, remains to be found. It is known, however, that cattle, especially Herefords, are generally of low quality, light of weight and small in size, when raised on the native pastures. Therefore it appears that whatever deficiency exists on native pastures can be overcome through pasture improvement and winter feeding.

By comparative chemical analyses of a large number of forage samples it is known that native pastures are very low in protein, calcium, and phosphorus as compared with those from improved pastures. These analyses also show that the improved pastures are below what is considered the required amount of calcium and phosphorus for short periods during the year. Thus the reason for feeding bonemeal with the salt as a lick to all cattle not on a specific mineral test even though bonemeal in previous force-fed tests did not give significant gains.

Therefore after this evidence has been obtained, the experimental herd is being used now to study means of bettering the situation where the pastures have already been improved and the importance of winter feeding recognized.

Bonemeal vs. Dicalcium Phosphate: This test was initiated on Nov. 2, 1938 and was mentioned in the 1938 annual report. It was designed to compare dicalcium phosphate with feeding bonemeal as a source of phosphorus. Twenty of the four-year-old Hereford cows were used with ten cows per group. The average weights, mineral consumption, etc., are given below.

	Average weight, lbs.		420 days Total Consumption, Ozs.			Calves	
	Beginning 11/2/38	12/26/39	Bonemeal	Dicalcium phosphate	Salt	Number raised	Ave. wt. on 10/4 of March and April, calves
Lot I.....	1,182.0	1,111.5	10,134.6	.....	5,061.5	5	380
Lot II.....	1,183.9	1,049.5	.....	1,249.6	3,154.9	7	386

Two parts of the bonemeal were mixed with one part of salt, and the dicalcium phosphate was mixed with the salt at the rate of 25 to 35 per cent. The mixtures were given free choice as a lick.

In general the cows on the dicalcium phosphate have indicated that it was not palatable, and these cows have never appeared as thrifty nor as glossy in their coats of hair as those on bonemeal.

The test will be conducted another year to determine whether the cows will parallel their past year's performance in consumption of the minerals.

Breeding Problems: Considerable difficulty has been encountered since 1937 in getting a normal per cent of the high-grade Hereford cows, in use on the station, to bring calves. In 1938 there was almost a complete failure in the calf crop with only three calves being raised out of 23 cows bred. At this time the herd bull was found to be not normally fertile and was replaced by a younger bull known to be fertile.

This year only 15 cows calved out of 23 bred. More difficulty than ever has been encountered during the past breeding season, starting June 1, in getting the cows settled. Both the pen breeding practice and the practice of turning the bull on pasture with the cows was followed. Neither practice was any more satisfactory than the other. Examination of the sperms of the present herd bull, indicates that he is not normal. The cows are tested annually for contagious and Trichomonos Abortion, and have always been found free of both diseases.

It is thought that this problem may be common to the entire region, and has never been fully recognized. No doubt it deserves further study.

Winter Feeding: The improved pastures usually cease to carry the cattle within two to four weeks after killing frosts, which on the average comes about November 15. For the first few weeks after the cattle are taken off the improved pastures, they are fed one to two pounds of cottonseed cake or meal and run on the unimproved timbered pastures. By the middle of December, on the average, it becomes necessary to start feeding roughage since the cattle are failing to take a fill on the native grass. At this time ensilage and hulls are added to the cottonseed meal and the herd is maintained almost entirely on this ration from then until about March 1 when the clovers in the improved pastures are of sufficient height to maintain them. Throughout this feeding period the herd is run on the timbered pasture, which affords some protection, but little if any grazing.

This past winter the ensilage fed was made of Leoti sorghum and enough was grown on four acres to feed the 28 head of grown cattle from December 22 to March 15. This ensilage crop was cut when nearly mature in August and placed in a small trench silo. Perhaps the main problem of trench silos in our soil type is caving, which can be overcome by reinforced plaster walls.

It is thought that silos and ensilage are of even more importance here than in the drier regions for three reasons: First, because they offer about the only satisfactory means of storing roughage in the open. Dry

roughage is hard to cure and difficult to save when stacked because of the weather; second, because ear corn and headed sorghums are soon destroyed or badly damaged by the heavy infestations of rats, mice, and weevils; third, because cattle need the laxative effect of ensilage to prevent constipated conditions that make their appearance among cattle in this area nearly every winter.

This winter the maintenance feeding began somewhat early or on December 1 because of the drouthy growing season. Red Top sorghum silage is being fed with cottonseed hulls and meal. The sorghum was very smutty when cut, but the cattle are eating greater amounts of it than they have the Leoti and sugar cane silage used in the past, which probably indicates a difference in quality. However, further studies to determine the best crop for silage in this region should be conducted.

A study on the merits of not adding water when filling the silo was conducted this year. About two-thirds of the silo was filled without adding any water and the remainder had water added in the usual amount. The ensilage put down without water is brighter, bulkier, freer from the sour odor, equally as free from spoilage, and is preferred by the cattle. The sorghum was almost mature when cut and placed in the silo.

Under the above feeding system, a grown cow can be wintered at a feed cost of from five to six dollars, which in itself is relatively high, but when it is considered that one to two acres of improved pasture will carry her and her calf through the remainder of the year then the cost no longer appears excessive.

Improved Pasture Grazing: The cattle herd was turned on these pastures March 7 this year where they remained with some exceptions until October 18, which was much earlier than usual because of the drouth. The pasture forage was so short by August that it became necessary to utilize a few acres of open semi-native pasture land elsewhere on the station. However the improved pastures furnished 206 days of grazing for twenty-three five-year-old cows, four two-year-old heifers, and fifteen calves. While on these pastures the cattle were rotated from one pasture to another frequently to control the height of the forage and to give fresh forage and variety to the cattle. No doubt the total acreage of 42 acres of these pastures could not have furnished so many days of grazing, with the prevailing weather conditions, had not the rotation and controlled grazing been practiced. Good fresh water was furnished in each five acre pasture through troughs. There were no shades available to the cattle. The cows were averaging 1160 pounds and the heifers 915 pounds when they came off the improved pastures October 18.

Presence and Abundance of Cattle Grubs: This study was begun on November 1, 1939, in cooperation with the Division of Entomology for the purpose of checking the abundance of grubs (wolves) in the experi-

mental cattle. Similar data are being collected at other stations, and all the data will be assembled and reported by the Entomology Division.

Other Cattle Work: The cattle became heavily infested with lice during the spring which necessitated several dippings. Two dippings were made this fall as a precaution against another infestation and also to rid the cattle of any ticks they might be carrying. Heel flies bothered some during the spring but the pest was bothersome here no more than in other regions. Wheat germ oil was fed to the herd bull for approximately 40 days in the late summer after he had failed to settle the cows. The treatment was evidently of no value. Another bull that was known to be fertile and also acclimated to the area was borrowed and used about 40 days, but he was not successful in settling all the cows. However, he did settle more than the herd bull.

Angora Goats: The same herd of goats described in the 1938 report was carried through this year and further observations were made. The purpose of these goats is to observe their adaptability to the region. Out of the 12 three-year-old does only three kids were dropped, two of which were raised. Both of these kids made normal growth, and their mother's strength was not taxed so greatly as had been observed in the mother does the previous year. The whole bunch thrived during the year with the does shearing an average of 4.57 pounds at the fall shearing. The registered Angora buck sheared 8 pounds. The average for the spring clip was slightly less. We find that since the soil is so loose and there are no outcrops of rocks that their feet should be trimmed two or three times per year at least. Two dippings in wettable sulphur dip controlled lice on them exceptionally well. As reported in 1938, it still appears that a breeding flock of Angoras will not be successful here, but that good shearing grown wethers should be successful. Based upon the fact that the does are shearing an average amount of hair, the wethers should produce an average amount, and they could be utilized also in keeping down underbrush, which is such a problem in pasture improvement. First crosses from the Angora buck and white Spanish does are carrying a surprisingly large amount of hair and some of the animals can hardly be distinguished from Angoras except on close observation. It appears that both a good breeding and shearing flock may be established through this method within three or four generations. If the quantity and quality of the hair increases at the same rate with further crosses, and if these crosses maintain the prolificacy of the Spanish goat and its thriftiness, then these crosses may be of considerable importance.

Permanent Pasture Studies: These investigations were mainly a continuation of those that were outlined and begun several years ago. Few additions have been made the last year or two because we have one pasture mixture that is giving good results and it is desired to investigate it thoroughly before moving on to new pasture research. The forage plant mixture that is giving good results, which is now the basis of the 42 acres

of improved pastures, is composed of carpet, Bermuda and dallis grasses; common lespedeza; and White Dutch hop, and Persian clovers. Given two years to become established, this mixture has had a carrying capacity of approximately one cow with calf to an acre and a half from 260 to 290 days per year. When the value of the mixture is measured in terms of growth and gains of the cattle, it might be restated that the two-year-old heifers, entirely raised on the pasture, were weighing 915 pounds when removed October 18. The highest gains are made in the spring when three pounds per head daily for 30 or 40 days on cows is not uncommon. This is due mainly to an abundance of the clovers at this period, and to the cows coming out of the winter in relatively poor condition. In general, they make rapid gains in the spring, lose some weight during the hot sultry summer, and make further gains in the fall. March and April calves usually average near 400 pounds at weaning (6 to 7 months), and dry cows usually get overly fat. In fact, this high degree of fleshing for long periods during the year has been advanced as a possible reason for the aforementioned breeding problems. In addition to furnishing forage of high carrying capacity and good nutrition, these pastures furnish a surplus which is cut for hay. Last year around 600 bales of hay were cut and this year nearly 400.

On a much smaller scale, studies to determine the best kind and amounts of fertilizer for pasture plants; searches for still better forage plants; investigation to ascertain the optimum number of trees to be left per acre for optimum yields of timber and forage, and searches for the best methods, date, depth, and time of planting the established forage plants are being conducted. At present it appears that the application of fertilizers to straight grass pastures is unprofitable; and becomes profitable only after clovers, lespedezas or both are added to the mixture. And the indications are that superphosphate is all that is necessary then, unless a small amount of nitrogen should be added to help in getting rapid establishment of these legumes. About 400 pounds of superphosphate for soils of average fertility seems to be the optimum amount to apply per acre. From the standpoint of the timber-pasture investigations, the fewest number of test pine trees per acre (175) will allow some grass growth, but it appears that the number will have to be less than 175 to reach the optimum return per acre from a combined timber and livestock operation. Of the 100 or more new forage plants under observation none have shown any marked promise during the year of being able to compete with the grasses and legumes used in the improved pasture mixture.

Temporary Pasture Studies: A few acres of *Alysicarpus vaginalis* (alsy clover) were planted for observation and test as a temporary summer pasture this spring. The plants grew more slowly than peas, peanuts, and other similar crops and thus were hard to cultivate and keep clean. The crop was not relished at first by cattle, but was later

grazed to the ground. However the plant's lack of vigorous early growth will probably prevent its use as a temporary pasture crop in this region.

A small acreage of New Nortex oats, wheat, barley, hairy vetch and wild winter peas was planted this fall as a continuation of the search for a suitable temporary winter pasture. To date trials with oats, rye, hairy vetch, Italian rye grass, Rescue grass, and yellow sweet clover have not been satisfactory.

Sugar Cane Studies

Sugar cane is grown in this region for sirup production entirely, and the variety most commonly used is Louisiana Purple. However, it has become so badly infected with mosaic disease that, coupled with the annual decrease in soil fertility, the yields of sirup per acre have decreased materially. This station is studying the ways of bringing the yields back to normal through the introduction of new varieties of sugar cane which have been developed and distributed by the United States Department of Agriculture for their resistance to or tolerance of the mosaic disease.

Variety Tests: The test described in the 1938 report was continued this year as a stubble crop. The yields were from highs of 236 and 216 gallons of sirup per acre for C. P. 807 and C. P. 28-11 respectively to lows of 34 and 59 gallons for two of the Louisiana Purple strains used as checks.

An experiment with planted cane using the twelve varieties listed in the 1938 report was made. The average yields of this test were somewhat smaller than those of the stubble, that is for the higher yielding varieties. A variety P. O. J. 36M that has heretofore been yielding a medium amount led this year with 240 gallons, followed closely by C. P. 29-320 and C. P. 28-11. The three Louisiana Purple strains continued to yield the smallest amount with an average of slightly over 100 gallons per acre.

Thus, after six years in which some of the improved varieties have consistently produced almost twice as much sirup as the native canes, it should be rather conclusive that they are superior.

The total production of the cane was curtailed on account of the dry season, and the per cent juice extraction was extremely low. However the per cent of solids in the juice was relatively high which made the cooking faster than usual.

The varieties Co. 290 and C. P. 807 that have consistently returned the highest production in the past, dropped to medium rank in the planted cane test.

Study of Fencing and Roofing Materials and Paints: This test was established in the fall in cooperation with the Division of Agricultural

Engineering. Annual surveys will be made on the various tests and reported to the above division.

E. K. Crouch, In Chg.

TOMATO DISEASE LABORATORY, JACKSONVILLE

In cooperation with the Division of Cotton and Other Fiber Crops and Diseases, Bureau of Plant Industry, U. S. Dept. of Agriculture, the interrelation of potash fertilizer, infection with *Fusarium vasinfectum*, and wilt resistance of cotton varieties were tested in their effects on the growth and yield of cotton. Use of 48 lb. of potash per acre gave an average increase of 217 lb. of seed cotton for the 12 varieties. The potash fertilizer decreased the percentage of wilted and dead plants 23 per cent in the wilt-susceptible Half and Half cotton. The following varieties were found to combine adequately strong resistance to *Fusarium vasinfectum* with large yields of long staple cotton: Cleve-wilt 6; Dixie Triumph 12; Dixie 14-5-2, Dixie Triumph 55-85, Miller 610, and Rowden 2088. Miller 610 was the best of the varieties as it gave a 3-year average yield of 852 lb. of seed cotton per acre. Miller 610 cotton has come into commercial use in Cherokee County. As in previous years, the cotton without potash fertilizer showed severe symptoms of potash starvation including yellowing and browning of the leaves, and severe defoliation in the drought in July.

Resistance of Cotton Varieties to Root-knot

The following cotton varieties showed root-knots caused by *Heterodera marioni* on 93 to 100 per cent of their plants growing in soil abundantly infested with the nematodes: Coker 100, Cook 144-68, Delta & Pine Lands 11A, Dixie 14-5-2, Half and Half, Miller 610, Rowden 2088, and Toole (Perry). Thus, these varieties showed no resistance to root-knot.

Wilt Resistance of Tomato Varieties

Extensive tests this year confirmed the conclusion from the preceding two years that root-knot decreased the resistance of most tomato varieties to wilt caused by *Fusarium lycopersici*. The weighted percentages of wilt resistance were determined for many varieties and selections of tomatoes. Such a wilt resistance of 60 to 100 per cent is needed in commercial varieties of tomatoes. The 3-year summary showed that the following varieties have this strong wilt resistance: Baltimore, Blair Forcing, Break O'Day, Buckeye State, Globelle, Grothens Red Globe, Illinois Baltimore, Illinois Pride, Long Calyx Forcing, Louisiana Pink, Louisiana Red, Marglobe, Marhio, Marvana, Marvel, Michigan State, Newport, Prairiana, Pritchard, Riverside, Rutgers, Sureset Forcing, and Tennessee Red. The yields of many varieties of tomatoes were determined in relation to their wilt resistance. The following resistant varieties were found to be satisfactory with yields of 4 to 5 tons of marketable

fruit per acre: Break O'Day, Illinois Baltimore, Louisiana Pink, Louisiana Red, Marglobe, Newport, Pritchard, Riverside, and Rutgers. Four selections of Bohn-Tucker crossed tomatoes were found to be immune to wilt caused by *Fusarium lycopersici*.

White-flowered Tomato

Further investigation of the white-flowered selection of tomatoes gave strong evidence that the yellow-flower character (Y) is dominant over the white-flower character (y). These characters segregated in a 3 to 1 Mendelian ratio. White-flowered plants apparently are homozygous recessive for white-flowers, and bred true through 3 generations tested. The white-flower character promises to be valuable as a marker for disease-resistant selections of tomatoes.

Sticky Tomato

The sticky tomato T328, appeared in 1938 probably as a mutation from T158 Prairiana. The fruits of T328 are flattened, unusually dark green, and the peel feels sticky on the green and ripe fruits. This sticky peel character presumably represented a new gene and occurred linked with abnormally light green leaves and very hairy stems in the tests in 1939. Seed from the original mutant plant produced 146 plants of which 135 were abnormally light green, hairy plants with sticky fruits while the remaining 11 plants were typical of the ancestor Prairiana.

Yellow Borders on Tomato Leaves

A new tomato gene is represented in selection T162 that has each year light green to yellow borders on many of its leaves. This character probably is recessive. It appeared as a mutation in T5 Marglobe seed treated with X-rays.

Tomato Breeding

Many varieties of tomatoes were crossed in the field and greenhouse in experiments planned to improve the tomato varieties found to be specially valuable in the wilt tests. These crosses included the Bohn-Tucker wilt immune tomatoes and Holmes hybrid of *Lycopersicon chilense* x *L. esculentum*.

Yellowing Near Stem Ends of Tomatoes

Green-wrap tomatoes in the fields showed prominent yellowing near the stem ends apparently resulting from direct sunshine. Ripening tests showed that the fruits with yellowed areas ripened sooner than did comparable green-wrap fruits without yellow areas. Graders at the packing sheds culled out the fruits with yellowed areas, treating them like they do pink tomatoes, so yellowing near the stem ends of green-wrap tomatoes caused large losses to farmers.

Tomato Dodder

Cuscuta indecora Chois. attacked tomatoes in the cold frames and fields, causing a new disease of tomatoes.

Blossom-end Rot

Resistance of tomato varieties to blossom-end rot was determined by calculating the number of fruits with blossom-end rot per plant in the field tests. Only one fruit with blossom-end rot per plant results in a loss of nearly 1/2 ton of fruit per acre. Thus, blossom-end rot caused a loss of 2 tons of fruit per acre in one selection of Rutgers tomatoes at the Laboratory, and in two commercial fields. The three-year summary showed that the following varieties of tomatoes were most resistant to blossom-end rot; as they had only 0 to 0.8 fruits with blossom-end rot per plant: Blair Forcing, Break O'Day, Globe, Long Calyx Forcing, Marglobe, Michigan State, Pritchard, Sureset Forcing, and Tennessee Red.

Chloropicrin Fumigation to Control Pathogens in Soil

Experiments with soil fumigation were continued from the preceding 3 years. Chloropicrin injected at rates of 300 to 450 lb. per acre, continued to give practical control of root-knot nematodes and *Fusarium lycopersici* causing tomato wilt.

Control of Damping-off of Tomato Seedlings

In tests continued from the preceding 3 years, seed treatment with Cuprocide, Metrox, and zinc oxide continued to help much in controlling pre-emergence damping-off of tomato seedlings. Adequate sunlight and soil-treatment with Semesan controlled post-emergence damping-off of tomato seedlings. Soil treatment with chloropicrin gave best results in controlling damping-off diseases.

Tests of Spray Chemicals on Tomatoes

Continuing the tests of the preceding years, tests were conducted to determine the effects of spray chemicals on yields of tomatoes. In this tomato season of abundant rain, the fungicides mostly caused little or no decrease in yields of fruit within two weeks after the tomatoes were sprayed. For the whole shipping-season of tomatoes, Basicop, Bordeaux, Coposil, Copper Hydro, Cuprocide 54, Cuprocide 54Y, U. S. 20, and Z-O resulted in increased yields of tomatoes while sulphur resulted in a slight decrease.

Katahdin vs. Bliss Triumph Potatoes

Katahdin and Bliss Triumph potatoes in a yield test planted and harvested on the same dates, showed that Katahdin (late variety) yielded

3.14 tons per acre, while Bliss Triumph (early variety) yielded 4.18 tons of tubers per acre. However, 7 times more Bliss Triumph tubers rotted than Katahdin tubers in the first 2 months of hot storage.

P. A. Young.

SUBSTATION NO. 12, CHILLICOTHE

Substation No. 12 is located four and one-half miles south and one mile west of Chillicothe, in Hardeman County, longitude 99 degrees west and latitude 34 degrees north, and elevation 1,406 feet above sea level. The Station serves a region in the upper Red River Valley where cotton, wheat, and sorghum are the principal crops. The soils of this part of the Rolling Plains area are predominately of the Vernon, Foard, Abilene, and Miles series. The average annual rainfall at this point is almost 25 inches.

The Station was established in 1905 on leased land as a forage crop testing station operated by the United States Department of Agriculture and the Texas Agricultural Experiment Station. The cooperation has continued to the present. In 1916 the State of Texas purchased 100 acres of land which comprises part of the present station and subsequently an additional 152 acres was acquired so that the present station consists of 252 acres.

During the early years an important phase of the work consisted of testing crops recently introduced from foreign countries and this early work resulted in the introduction of Sudan grass and the grain sorghums Hegari and Feterita and in the distribution of Dwarf Yellow milo.

In common with all others, this station is collecting reliable information on the proper procedure in crop production and soil management. Varietal and cultural experiments are being made with all the important crops. Some attention is being devoted to vegetables and fruits for production in home gardens and orchards and to ornamental plantings of trees and shrubs.

The unique feature of the work at this station is the investigations under way with sorghums. The most complete nursery of both forage and grain types of sorghums in America is maintained at this point. An intensive study of sorghum inheritance is under way and the production of new and superior varieties is the aim of an inclusive breeding program.

Experiments with Sorghums

(In cooperation with the Bureau of Plant Industry, U. S. D. A.)

Sorghum Variety Test: The season was unfavorable in all plantings from April to June. Chinch bugs were present in damaging numbers and the milos suffered worse than other varieties. Kalo was the outstanding variety in yield of grain with an average of 22.5 bushels from an April and a June planting. Kafir produced almost 20 bushels and Hegari only 3.4

bushels. Early Hegari, a new strain that is about 20 days earlier than the ordinary strain when planting is done in June, produced a 10.1 bushel average. This new strain is a promising addition to the list of varieties for West Texas as it produces good yields of both forage and grain.

Date of Planting: During the past six years average grain yields of seven representative grain sorghum varieties from April, May and June plantings were 20.6, 19.3, and 19.6 bushels to the acre. Corresponding forage yields of five sorgho varieties were 2.60, 2.93, and 2.72 tons air-dry.

Yield of Pythium Resistant Strains: Resistant strains of most of the important varieties have now been distributed or are ready for distribution in the spring of 1940. In 1939 a comparison of resistant and susceptible strains of Dwarf Yellow milo, Dwarf White milo, Double Dwarf Yellow milo, Early White milo, Darso, and Wheatland showed that on the average the susceptible strains produced only 37 per cent as much as the resistant strains. Losses from growing susceptible strains as great as this have occurred before and are about what is to be expected if resistant strains are not grown.

Sorghum Breeding: Work during 1939 resulted in the isolation of strains of Sooner milo resistant to *Pythium arrhenomanes* and a small amount of seed will be distributed in the spring of 1940. In the spring of 1939 distribution of Pythium Root Rot resistant strains of Darso and Double Dwarf milo were made to Certified Seed growers and other interested farmers. A search for strains of the important grain sorghum varieties that are resistant to *Sclerotium bataticola*, the Charcoal Rot disease, has not been fruitful of results as yet.

Sudan Grass Breeding: The work of obtaining a non-seed-shattering, sweet-stemmed, juicy Sudan grass of distinctive seed color is progressing satisfactorily. Sweetness, juiciness, non-shattering seed habit, a certain amount of resistance to several foliage diseases, and sienna glume color have been introduced into Sudan grass by crossing with Leoti sorgho. The breeding process has consisted of back-crossing to Sudan grass several times with selection following each hybridization. All of the desirable characteristics have not been obtained in a single strain as yet but inter-crossing between hybrid strains during the past two years has resulted in plants in 1939 that are expected to yield progenies that will show them to be suitable for increase.

Hybrid Vigor in Sorghum: A paper on male sterility in Sorghum was published in 1937 and in that paper it was pointed out that three requirements need to be met before hybrid Sorghum can become a commercial reality. It would be necessary to devise effective means of getting good sets of seed with wind-blown pollen; it is desirable to discover closely-linked characters so that male sterile plants of the female line can be readily detected previous to the time of blooming, preferably at the time of thinning; and lines must be found or produced that will yield maximum

vigor in the F_1 generation without sacrificing dwarfness or reasonably early maturity.

The effort in 1939 has been in the direction of attaining the objectives outlined above. Ten foundation lines for establishing male sterile strains were isolated. Each of these lines carries male sterility, presence of awns, and a virescent yellow character in the coupling phase. Probably none of these lines will be useful in its present form as a female parent for the production of hybrid seed, but by crossing with appropriate varieties and successive back-crossing it should be possible to establish lines of the desired types. A large number of crosses using these lines was made during the blooming period. It will take a number of years to solve all of the problems in connection with the production of hybrid sorghum but the work of each year brings the idea closer to reality.

Inheritance Studies: This work which comprises one of the major activities at this Station is resulting in the accumulation of knowledge of the genetics of sorghum that is contributing to the breeding program with Sorghum in this as well as other states. During recent years this particular phase of work has been enlarged as the result of support received from the Works Progress Administration in the way of labor and laboratory assistance.

A very serious drought hampered the work this year and the completion of a number of studies that should have been finished in 1939 will have to await another growing season. The inheritance and linkage relationship of numerous characters in sorghum continue to be studied. So far two linkage groups of three characters each have been reported upon in publications and two other linkage groups are known of but the exact cross-over percentages have not as yet been determined.

Two previously unobserved seedling characters were found in genetic stocks this year. One is a pale yellow and the other a green stripe. Both appear to be entirely lethal although some individuals survive beyond exhaustion of endosperm food reserves and both were approximately 25 per cent of the populations in which they occurred. Also two mature plant characters were received from other workers. One is a chlorophyll deficiency and the other a red discoloration but type of inheritance was not determined except that both are recessive to normal green.

Cotton Experiments

Cotton Variety Test: Production in 1939 was in the neighborhood of one-half bale to the acre. The season was unfavorable after August 20 because of high temperatures and lack of rain and there was no top crop. Under such conditions, the varieties differed in production less than when conditions are more favorable. Watson was the outstanding variety in point of yield. During the five-year period of 1935 to 1939, inclusive, Western Mebane 140, Jumbo, Western Mebane 141, Half & Half, and

New Boykin have greatest productions in the order named. Acala and D.P.L., the varieties of inch to one and one-eighth inch staple that were planted extensively in 1939 in this area, have produced from 10 to 20 per cent less lint cotton during the five-year period than several varieties of shorter staple. The performance of Acala in particular was unsatisfactory as the character of the lint was undesirable.

Date of Planting: For the sixth consecutive year serious drought conditions existed during the month of August. High temperatures were particularly injurious during the latter part of August and the early part of September. Under these circumstances the greatest yield (286 pounds) was produced from the earliest planting which was made on April 22; the May planting was next in production (255 pounds); and the June planting produced the least (215 pounds). During the past eleven years there have been large differences in production between the different dates of planting but no date of planting has been consistently the best. In view of the impossibility of predicting the climatic conditions in any particular season, the most desirable date of planting is determined by factors other than yield. The general practice of planting during the first warm weather of late April or during May and continuing to plant until a good stand is obtained or until the cotton comes up free from weeds is a good one. Cotton can be planted safely until at least June 20. A planting in 1939 made on July 1 and not in the regular date of planting test produced a crop of 200 pounds of lint cotton per acre.

Control of the Cotton Flea Hopper: Except for drought, this insect influences the production of cotton in this area more than any other factor. This year infestation occurred suddenly about July 20 and as many as 50 nymphs on 100 plants were present within a few days. Where not controlled the insect was present in the crop throughout all of August and September. Over most of this territory cotton blossoms were scarce after August 15. Where control was exercised by dusting with sulfur the insects were killed without trouble. In dusted areas cotton blooms were numerous during August and September but were shed immediately after blooming due to unfavorable climatic conditions. There was a similar occurrence in 1938. During the past two years, therefore, there has been good control of the insect without any appreciable increase in production.

Cotton Breeding: Western Mebane 140 and 141, the product of selection at this Station during past years, have continued to produce well and both are now being produced in quantity by Certified Seed Growers. The Station increase area was devoted entirely to Western Mebane 140. Ordinary progeny row selection is being used to maintain the purity of these two strains. In addition to this work, selections are being made in the progeny of a Lankart x Mebane strain. Certain selections out of this cross are promising from the standpoint of length of staple and one strain that was included in the cotton variety test produced 50 pounds of lint to the acre more than the next highest yielding variety.

Cotton Fertilizer Test: This test using commercial fertilizers, cotton-seed meal, and barnyard manure has been conducted for twelve years using the same area for each application during the entire twelve years. The results indicate that fertilizer applications of no kind have resulted in increased yields. Applications of barnyard manure have been no more effective in increasing yields than other treatments. Duplicate plats upon which 5 tons of manure per acre has been put each year adjoin plats that have been without treatment. The average production for the entire period of years is 192 pounds for the plats of no treatment and 187 pounds for the manured plats. Likewise plats without treatment adjoin two plats upon which 400 pounds of a 4-8-4 fertilizer has been applied each year. The average yield for the fertilized plats for the entire period is 197 pounds and that of the untreated plats is 198 pounds. The soil is Abilene fine sandy loam and it is apparent that plant food is not a limiting factor in production.

Experiments with Corn

The corn crop was poor on account of high temperatures and hot winds that occurred during the period of June 9 to June 18. Eighteen Corn-Belt hybrids and one hybrid from Virginia were included in the variety test along with eight Texas varieties. Yields between two and eight bushels per acre were the usual thing and the hybrids were on the average slightly higher than the Texas open-pollinated varieties but none were sufficiently better to justify general planting.

Breeding work with the Golden June variety continued with the intention of improving grain color and increasing uniformity. The grain color has been greatly improved in a period of four years and undesirable plant types are disappearing.

Small Grain

(In cooperation with Bureau of Plant Industry, U. S. D. A.)

Wheat Variety Test: Yields of the 16 winter wheat varieties were between 28.8 and 34.0 bushels to the acre. Yields of the well adapted hard wheat varieties including Blackhull, Tenmarq, Kanred, Quivera, and Oro x Tenmarq differed by less than the experimental error. Over a period of years Blackhull, Tenmarq and Kanred have produced average yields of 22.5, 22.4, and 21.9 bushels. Since the production of these varieties is so close together other characteristics such as milling quality, test weight, and ability to stand up are important considerations. Blackhull always produces grain with the greatest test weight and Tenmarq is a little lacking in this respect, but anyone of the three mentioned varieties is suitable to grow. These varieties will undoubtedly occupy the major part of the acreage in this area until such a time as a well adapted hard winter variety that is resistant to bunt is distributed. It is possible that Oro x Tenmarq whose production is very slightly below that of Kanred may prove to be worthy of distribution.

Winter Wheat Nursery: One hundred and twenty strains and varieties were included using seed obtained from the Denton Station. An inclusive plant breeding program is being conducted by the Division of Cereal Crops and Diseases of the U. S. Department of Agriculture in cooperation with the various States and this nursery is being grown for the purpose of testing the many superior strains that have been produced at the Denton Station and in other States. The breeding program has for its aim the production of good milling varieties that have good production, resistance to rust and smut, and resistance to lodging.

Barley Variety Test: For the second year the Wintex variety was outstanding in production. The production of this variety was 40 bushels to the acre as compared with productions of 27.8 and 18.8 bushels for Tennessee Winter and Missouri Beardless varieties. Wintex barley originated at the Denton Station. A ten-acre increase was grown at Chillicothe in 1939 and the seed was distributed.

Soybeans

(In cooperation with the Bureau of Plant Industry, U. S. D. A.)

Three hundred strains of soybeans out of a total of five hundred and twenty-six that were grown in 1938 made sufficient seed in that year to allow planting in 1939. The season was not favorable and growth and production was not as good in 1939 as in 1938. Rabbits were hard to control this season and damage was excessive due to the fact that growth of the crop was not great enough to cause the rabbits to graze relatively small areas as was the case in 1938. A few varieties were found that were not well liked by the rabbits and these rows produced the most seed. Production of the best strains was only about 300 pounds to the acre. A few varieties in each range of maturity were considerably better than others and, although production was not good, the bare possibility remains that among these new varieties one or two will be found that are adapted to this area.

Alfalfa

(In cooperation with the Bureau of Plant Industry, U. S. D. A.)

There is renewed interest in alfalfa largely as a result of the AAA program. Since stands of alfalfa are becoming harder to maintain in this territory and in view of the advent and spread of alfalfa insects and diseases it seemed desirable to expand the work with this crop to some extent. Consequently in the spring of 1939 a planting of a "Uniform Alfalfa Nursery" was made. This nursery consists of approximately 50 strains that have been recognized as having merit at some Stations in the United States and similar nurseries are being planted in almost all States. Seed was obtained through the Division of Forage Crops and Diseases. This planting came to a good stand but growing conditions were not favorable after August 15 and many plats died. In the fall remnant

seed was sown in the vacant areas of the rows and in addition a second nursery was planted using a new supply of seed obtained from the same source as previously. In addition to this "Uniform Nursery" about 600 selections made at Chillicothe from Grimm, Dakota No. 12, Kansas Common, Turkestan, and Chillicothe Common were planted in nursery rows. No yields were taken as uniform stands had not been established.

J. R. Quinby and J. C. Stephens.

SUBSTATION NO. 14, SONORA

Substation No. 14, Ranch Experiment Station, is located in Edwards and Sutton Counties and comprises 3,461.6 acres. The latitude is 32 degrees north and longitude 100 degrees west; the elevation is approximately 2,400 feet above sea level. The average annual rainfall over a period of 21 years is 24.26 inches. This year shows 6.91 inches less than average. Sixty acres are in cultivation for the growing of feed crops while the balance is used for grazing purposes.

The station was established for purpose of serving an extensive area known generally as the Edwards Plateau region, where livestock is the predominating agricultural resource. Sheep, goats, and cattle are the principal livestock of the region. This region produces the great bulk of the sheep produced in Texas, which ranks first of all the states in the number of sheep and the quantity and quality of wool produced. The region also produces the greatest bulk of the Angora goats, producing 86 per cent of the nation's crop of mohair.

Studies in diseases of livestock, particularly the diseases of sheep and goats, constitute part of the station's activities, inasmuch as these occur under range conditions where, unlike other sections, loose herding is quite generally practiced. Another part is the study of inheritance of desirable and undesirable characters in sheep and goats. The study of external and internal parasites affecting livestock is also included. Other problems relate to the study of the forms of vegetation that make up the range feed value, the number, diversity, and occurrence of these different species, and the sequence in which they occur and contribute to the total carrying capacity of the range.

Cultivated Crops, Shrubs, Flowers, and Vegetables

Sixty acres of land are in cultivation for the production of feed for livestock. Sorghums constitute the main crop. This year approximately 3,500 bundles were harvested and stacked. In addition the upright silo at headquarters was filled. The silage will be utilized during the lambing and kidding operations or preserved until more adverse range conditions exist. The trench silo filled in the fall of 1938 was not used this year. Records for feed crops planted here show excellent yields for four years out of six.

No experimental work is done with vegetable gardens, but the residences on the station have been able to produce early spring and fall products of radishes, spinach, onions, beans, beets, carrots, okra, turnips and potatoes. Tomatoes are invariably killed out by a disease believed to be wilt.

The most satisfactory flowers grown here seem to be sweet peas, zinnias, chrysanthemums, various bulb plants, morning glory, and castor beans.

The introduced shrubs on the station, including privet, arborvitae, juniper, cypress, and Nandina, have grown satisfactorily and have greatly improved the landscape. The planting of yucca, cacti, senecia, and Huajillo, which are native, have been well established in some of the yards. More native shrubs, such as rosin bush and rubber plants, have been planted. Two of the rosin bushes died from root rot last year. Two fig trees irrigated have produced abundant crops of fruit for several years. An inadequate water supply for irrigation purposes prevents proper upkeep of yards and gardens.

W. H. Dameron.

Spineless Cactus

No additional work was done with Spineless Cactus this year. The acreage which was permitted to be grazed by sheep in 1938 to control bitterweed trouble on the range was allowed to rest and produce new growth from the old stumps. It will probably require three to four more years before it can be utilized again.

W. H. Dameron.

Bitterweed Control Studies

Good progress has been made at this station in the past 8 years in decreasing our bitterweed infestation by reducing the stocking rate from 64 units to 50. Grass cover has replaced bitterweed about 100 per cent on favorable grass growing areas, but the old lake beds and depressions remain covered predominantly with bitterweed. In an effort to improve these areas they were sown to Italian Rye grass in the falls of 1937 and 1938. The results in 1938 were very satisfactory in that all areas devoid of grass turf produced an excellent quantity of valuable forage for grazing instead of a solid cover of bitterweed. Results this year, however, were not satisfactory on account of deficient moisture conditions.

An attempt is being made at this Station to increase desirable winter forage and decrease bitterweed by deferred grazing. In February, 1937, permanent meter square quadrats were staked off in Pastures E and I where the vegetation on the quadrats was charted. Pasture E was then vacated and remained so until June of that year, while Pasture I remained stocked as usual. Subsequent chartings of the vegetation on the quadrats were made periodically until the vegetation had matured and produced seed crops which was in June. The same practice was followed for both pastures in 1938 and 1939. Eighteen different varieties of plants, winter

and spring growing were recorded during the February and March chartings in the two pastures during 1938 but on account of deficient rainfall this year there was very little germination of plants in either pasture.

The bitterweed has shown some increase in Pasture E while in Pasture I it shows a small decrease. Perhaps the period of rest for Pasture E had something to do with this or it may be that a heavier cover of winter annuals on the ground, which require considerable moisture, tends to prevent or delay grass growth during the spring and early summer.

Since there has been some increase in the bitterweed count, as well as of other plants, Pasture E that was rested from February to June, we vacated Pasture I this year from June to November 1st to get a comparison of summer rest versus spring rest. Deficient rainfall during the summer prevented growth and adequate vegetation cover on Pasture I to control bitterweed germination in the fall.

W. H. Dameron and V. L. Cory.

Bitterweed Range Station

(In cooperation with the University of Texas.)

The University of Texas owns approximately 2,000,000 acres of grazing land in Southwest Texas which is operated on a cash rental basis to stockmen for grazing purposes. In some areas this land has become heavily infested with bitterweed the same as numerous ranches privately owned. It is a problem of common interest to all the property owners and operators to know how to cope with this encroachment of bitterweed in producing an income from the land.

Livestock Production

On this Station we are testing several different systems of pasture management for comparison of behavior of the vegetation and livestock production. In the pastures where we have a combination of sheep and cattle on a 3 months rotative grazing plan, lamb production was 12 per cent less and the lambs 2 pounds lighter than on a continuous grazing plan. The percentages of calves weaned were the same but the calves from the rotative group were 130 pounds per head heavier than from the continuous group.

In comparing rotative grazing and continuous grazing with straight sheep we got 1½ per cent more lambs but they were 4 pounds per head lighter. For cattle under the same pasture management plan, calves from the rotative pastures were 10 per cent less but they weighed 18 pounds per head more at weaning time.

Since this problem is becoming more serious from year to year by the spread of the bitterweed menace and in that it threatens to involve all of the ranching area of the state, a cooperative project on range

management studies was set up on 3160 acres of University land between Ozona and Barnhart, Texas, during the spring of 1938.

This range is about average so far as former range abuse and present noxious plants are concerned. It is about typical of some three to four million acres of flat rolling country which surrounds it. The average annual rainfall is about twenty inches. This year it was 24.24 inches. The soil is mostly deep and fertile. The vegetative cover consists mostly of Buffalo, mesquite and tobosa grasses. Mesquite bushes and prickly pear constitute the shrubs. There is a fair variety of forbs but the quantity is limited. The only weed of any consequence or concern is bitterweed (*Actinea odorata*).

The sheep and cattle used in this study did not have a production record last year (except for wool from the sheep) in that they were not of production age then. The wool on the sheep last year was grown before the sheep came into our possession.

The vegetation production record for the station is to be found under the Division of Agronomy.

Feed Production

Approximately 225 tons of sorghum, which was harvested as silage, was produced this year, and stored in trench silos, to be used for feed in case of prolonged adverse range conditions, or through the danger period of bitterweed poisoning.

Maintaining Sheep on Bitterweed Range

From March 6 to 29, 166 grade ewes were successfully fed and lambbed in Pasture C on 3 pounds sorghum silage and $\frac{1}{4}$ pound cottonseed meal per head daily. These sheep had previously been poisoned on bitterweed to the extent that 33 $\frac{1}{3}$ per cent of them showed symptoms. No trouble was experienced after getting them on feed. They raised an 87 per cent lamb crop.

This is the third successful year in feeding sheep silage on bitterweed range without trouble of any kind.

Cottonseed Meal Feeding Test

There continues to be a great demand for practical methods of feeding sheep on the range in this area during adverse range conditions. In order to get some information on this subject when only a rich protein supplement is required we fed 158 head straight cottonseed meal from January 4 to January 24. They were fed $\frac{1}{3}$ pound per head daily at 8:30 a. m. in flat-bottomed troughs with adequate space for all to eat if they came in. Regardless of whether they all came in the full amount of feed was put out.

Ten observations were made with the lowest number in 1 day being 66 head while the greatest was 158 head or all of the sheep. The average per day was 105 head.

During the three week period the sheep made an average gain of 1/3 lb. each per day and none of them showed any symptoms of overconsumption of cottonseed meal.

The pasture used was approximately 1 section in size, rough and brushy.

The salt mixture during the test was 50 per cent salt and 50 per cent pulverized oyster shell.

Animal Breeding Investigations

This station maintains a flock each of registered sheep and goats used primarily for studies on:

1. Inheritance of polled character in fine wool sheep.
2. Inheritance of the ridgling characteristic of goats.
3. Inheritance of skin folds on Rambouillet sheep.
4. Inheritance of type in Angora goats.
5. Relation of age of animal to fineness of wool or mohair.
6. Determining grades and shrinkages of wool and mohair.

There were 22 registered Rambouillet rams, 200 registered Rambouillet ewes, 27 Corriedale and Rambouillet-Corriedale cross ewes, 81 ram lambs, 73 ewe lambs, 15 registered Angora bucks, 234 registered Angora does, 55 Angora buck kids and 50 Angora doe kids involved in the studies on these projects this year. Individual body, physical and fleece descriptions were recorded on all of these sheep and goats this year. They are reported on under Division of Range Animal Husbandry.

In addition to the registered sheep we maintained 166 bred purebred Rambouillet ewes and 43 lambs for sire testing purposes and miscellaneous feeding tests.

Veterinary Science

Swellhead in Sheep and Goats

Inactive.

I. B. Boughton and W. T. Hardy.

Soremouth (Contagious Ecthyma) of Sheep and Goats

Work on this project was confined to the production, testing and shipment of 512,740 doses of vaccine.

Experimental and field work in previous years has demonstrated the cause, symptoms, etc., of this condition. Since the development and wide use of the vaccine it has become less and less of an economic problem among range sheep.

I. B. Boughton and W. T. Hardy.

Stomach Worms (*Haemonchus contortus*) in Sheep and Goats

Work during the year has been confined to immunity studies with sheep which had been artificially infested with stomach worms (by drenching with known unumbers of live infective larvae) and subsequent exposure on known *H. contortus* infested pastures.

A parasite-free lamb, drenched with 4200, 4285, 5200, 4200, 5040 and 7200 infective larvae respectively on six consecutive days and 7328 and 15900 larvae respectively 20 and 28 days later, remained healthy during an eight months observation period in the barn. For the next $3\frac{1}{2}$ months it was running in an infested pasture and remained healthy. At this time it was drenched with 18,750 larvae and held in the barn for eight months during which time it remained healthy. Turned into an infested pasture the animal remains in excellent condition at present, nineteen months later. And fecal egg counts, made at bimonthly intervals, have remained consistently low.

Another parasite-free lamb which received orally 115,390 larvae in nine separate doses during 34 consecutive days, showed clinical symptoms of haemonchosis after 60 days and recovered spontaneously within the next ten days. Eleven months after the last dose of larvae this animal was turned into a known infested pasture where it remains in excellent condition at present, 43 months later.

Another parasite-free lamb, drenched with 45 live mature *H. contortus* showed eggs in the feces for the next 11 months. Receiving 18,000 larvae at this time, peak egg production was reached in 60 days and then declined to less than 400 eggs per gram within ten days. In excellent condition at present this animal has been running in an infested pasture for the past 31 months.

Three yearling parasite-free lambs, dropped and raised in concrete stalls, remain in good condition and the occasional fecal examinations show very low egg counts although they have been running in an *H. contortus* infested pasture for the past $8\frac{1}{2}$ months.

I. B. Boughton and W. T. Hardy.

Hard Yellow Livers of Sheep and Cattle

So far as we were able to determine no new cases of the disease developed during the year under review.

Feeding tests of the plant, *Senecio longilobus*, were continued; mature plants, seedling plants, flowers and ripe seed were fed to sheep. At present there are eleven such animals under observation.

One sheep consumed 61.875 per cent body weight of young weed at the rate of .125 per cent bdy. wgt. per dose in 495 feedings during 501 consecutive days. This animal died on the 508th day of the test and showed a severely cirrhotic liver at autopsy.

One sheep, fed 62 per cent bdy. wgt. of mature weed at the rate of 2 per cent bdy. wgt. per dose during 77 consecutive days, died 250 days after last feeding from chronic poisoning. Gross appearance of the liver and microscopic study showed changes practically indistinguishable from those seen in some field cases of hard yellow liver.

A sheep, fed 52.25 per cent body wgt. of mature weed at the rate of 25 per cent bdy. wgt. per dose, in 209 feedings during 245 consecutive days, died in the pasture 154 days later. Gross and microscopic liver and kidney changes were practically the same as those seen in some field cases of hard yellow liver.

A sheep consumed 63 per cent body weight of mature weed at the rate of 1 per cent bdy. wgt. per dose during 77 consecutive days. Turned to pasture this animal died of chronic *S. longilobus* poisoning 410 days later. Gross and microscopic liver changes were extremely suggestive of field cases of hard yellow liver.

I. B. Boughton and W. T. Hardy.

Feeding Trials of Suspected Plants

Nama Hispidium, var. *Mentzelli*. Leaves fed in large doses to two sheep were not toxic.

Florestina Tripteris. The leaves in a dose of .5 per cent body weight killed a sheep in 33 minutes. This plant contains hydrocyanic acid (Sodium Pictrate Test).

Solanum Eleagnifolium. Sheep fed .52 per cent body weight of ripe fruit died in 25 minutes after manifesting symptoms of severe dyspnea. The green leaves of this plant were not toxic for sheep. Another sheep, fed .72 per cent body weight of ripe fruit showed severe dyspnea but recovered as did a six months old calf which received two doses of .31 per cent body weight each about six hours apart. A mature mutton fed the green leaves remained normal.

Solanum Torreyi. The ripe fruit was not toxic to a sheep fed 14 per cent body weight in 14 days nor to a calf fed 14.8 per cent body weight in 52 days. The green fruit, in 3 per cent body weight dosage, was toxic but not fatal for a mature sheep.

Peganum Harmala. Leaves of the mature plant were fatally toxic for a mature sheep fed 3.63 per cent body weight in one dose. Doses smaller than this were not toxic.

Kallstroemia Intermedia. Leaves and stems were not toxic for a sheep fed 2.32 per cent body weight.

Helenium Microcephalum (Sneeze Weed). The leaves were rapidly fatal for mature sheep in dosages as low as .25 per cent body weight. One sheep died of chronic poisoning on the 57th day after receiving 3.2 per cent body weight of leaves at the rate of .0625 per cent body weight

per feed. A six months old calf died of acute poisoning 7 hours after receiving .25 per cent body weight of leaves at one dose.

Feeding tests showed that the seedling weed is definitely not as toxic as the mature plant.

Jatropha Spathulata. The green leaves in 2 per cent body weight doses were toxic but not fatal to a sheep. The nuts of this plant were fatal to a lamb fed a total of 2.96 per cent body weight in three separate doses during twelve consecutive days.

Stillingia Treculeana. The leaves and stem tips of this plant contain hydrocyanic acid (Sodium Picrate Test). A sheep died 70 minutes after receiving .5 per cent body weight of leaves. Another sheep died after receiving a total of 1.25 per cent body weight of leaves at the rate of .25 per cent body weight per feed during five days.

Sesbania Vesicaria (Coffee Bean). The beans were rapidly fatal to sheep in dosages of .125 per cent body weight or more, and killed a sheep 53 hours after it was fed .0625 per cent body weight. Dosages of .03125 per cent and .0156 per cent body weight were toxic but not fatal to mature sheep.

Cassia Lindheimeriana Scheele. The leaves of this weed were toxic for but not fatal to a mature sheep fed a total of 5 per cent body weight during three consecutive days.

I. B. Boughton and W. T. Hardy.

Miscellaneous. Infectious Entero-Toxemia of Lambs

Pen experiments during previous years showed that animals injected with a 2 per cent zinc chloride toxoid of the causative organism, *Clostridium Welchii*, Type D, developed a measurable amount of antitoxin in the blood stream within about three weeks and that such antitoxin persisted for at least five months. Other tests showed that a measurable amount of antitoxin was secreted in the milk of toxoid-treated ewes.

Work during the year consisted largely of field experiments in which pregnant ewes were given this toxoid about one month prior to lambing. The idea was to determine whether sufficient antitoxin would be secured through the milk by the nursing lamb to protect it against the disease during the dangerous season.

In this work a total of 4,034 pregnant ewes were injected with the toxoid and 7,387 pregnant ewes were left as controls on six different ranches. Four lambs (.09 per cent) dropped by the treated ewes died from entero-toxemia while 38 lambs (.51 per cent) dropped by the control ewes succumbed to the disease.

FIELD EXPERIMENTS

	Number Pregnant Ewes	Treatment	Lambs Died Ent.-Tox.
Ranch A	340 1900	1 cc. each, subc. $ZnCl_2$ Tox..... None. Controls.....	None 30 (1.68%)
Ranch B	481 481	1 cc. each, subc. $ZnCl_2$ Tox..... None. Controls.....	None None
Ranch C	225	1 cc. each, subc. $ZnCl_2$	4 Owner claims loss year be- fore was 80% of lamb crop.
Ranch D	892 106	1 cc. each, subc. $ZnCl_2$ Tox..... None. Controls.....	None None
Ranch E	162 400	1 cc. each, subc. $ZnCl_2$ Tox..... None. Controls.....	None Eight
Ranch F	1934 4500	1 cc. each, subc. $ZnCl_2$ Tox..... None. Controls.....	None None

This disease was not encountered in calves during the present year.

"Limberleg" of Sheep: This peculiar nervous malady, of unknown cause, appeared over a large territory and caused very severe losses during the year under review.

We have not been able to transmit the disease to healthy animals and tests have indicated that the condition is not a mineral deficiency.

Investigations and vegetation surveys on many different ranches where the disease occurred were made. Feeding tests of the predominating range plant, Guajillo (*Acacia Berlandieri*), both as the fresh green plant and in the form of alcoholic and watery extracts, are being fed to sheep at the time of this report.

Larvae of *Cochlymia Americana* (Screw Worms): Intradermal and subcutaneous injection of extracts of these larvae into sheep did not induce any resistance to the live larvae when they were introduced into fresh cuts in the skin of the test animals approximately three weeks after extract injection.

Pregnancy Disease: Six ewes, due to lamb within six weeks, were placed in concrete stalls on an individual daily ration of $\frac{1}{4}$ lb. cottonseed meal and 1 lb. dry, brown Johnson Grass hay in an effort to produce pregnancy disease. The animals were kept in the stalls on this ration until they lambed.

Five animals developed ketone bodies in the urine (Nitroprusside Test) in from 14 to 28 days after the test started. All of these animals lambed normally, while the sixth animal was not pregnant.

Laboratory Specimens: A total of 701 specimens, diagnostic and experimental, were handed during the year.

I. B. Boughton and W. T. Hardy.

Calcium and Phosphorus Requirements in Edwards Plateau

During the second year of this experiment three groups of range sheep were bled at monthly intervals and the amounts of calcium and inorganic phosphorus in the blood serum determined. The fourth group was tested monthly until September when the owner disposed of the animals. A fourth group of 24 range sheep on a ranch in western Crockett County were placed in the experiment and bled in November and December.

None of the groups received supplemental feed except for a period during the fall and early winter when the shortness of the range vegetation necessitated some additional feed.

Analysis of the results of the monthly tests shows that none of the animals on any of the ranches suffered from either a calcium or phosphorus deficiency during the year. Naturally there was a seasonal variation in the amounts of these minerals in the blood and such variation could be rather closely correlated with the seasonal changes in the range vegetation. The lowest figures for inorganic phosphorous occurred among the sheep on the ranch in Pecos County. The cattle on this ranch often develop unmistakable symptoms of phosphorous deficiency during the winter unless they are given supplemental feed rich in this mineral. While the sheep showed relatively low phosphorous figures during the early winter months they did not at any time exhibit any clinical signs of deficiency.

I. B. Boughton.

Bitterweed Control Studies

In a section-pasture of Texas Substation No. 14 a test was initiated last year to gain information concerning the value of deferred grazing for the first half of the year as contrasted with the continuous grazing of an adjoining pasture nearly as large. Inasmuch as the indications the first year were not as favorable as was hopefully expected it was decided to change the test in such manner as to contrast the deferred grazing at different periods of the year by changing from continuous grazing in the smaller pasture to deferred grazing for several months onward from the month of June. This year, therefore, the results for the second year of deferred grazing the first half of the year and for the first year of deferred grazing for the second half of the year are available. This material indicates that the later season of deferred grazing offers more hope for favorable results in the control of bitterweed.

The similar study on a ranch in Sutton County, located 17 miles east of Texas Substation No. 14, was made for the second year. At this location one pasture is free from livestock from the middle of April to the middle

of October while the other is being pastured with cattle, sheep, and goats. Then the process is reversed for the ensuing period. Vegetation counts are made in these two pastures preceding the moving of the livestock. Bitterweed was not present in much abundance in either pasture this year. The indication remains the same as last year when more promise for helpful results was shown in the pasture not stocked with livestock during the summer and fall.

The bitterweed control work on a ranch in western Schleicher County this year afforded little of value because of the fact that bitterweed was not abundant in the pastures concerned. In the small pasture, or trap, the grazing is light and seasonal, it being used mostly as a pasture for the flock of breeding rams. In this pasture bitterweed is largely confined to small spots which are devoid of grass, and such spots are scattered or are more or less grouped in certain areas. In the larger pasture on the west the grazing is relatively heavy as well as being continuous, and with both sheep and cattle, but with more emphasis on cattle. The one enclosure in this pasture is one acre in area and is located in an area mostly devoid of grass and usually dominant with bitterweed. There was very little bitterweed this year, and such was the case also last year, but in a year when conditions are favorable for the growth of this plant the enclosure, having already regained a good grass cover, will have bitterweed only in a few scattered bare spots while around outside the enclosure bitterweed will again be the dominant plant. On the Eldorado Plains, or the Divide Country, it appears probable that the numerous small barren spots, so far as a grass-cover is concerned, offer more difficulty to a successful control of bitterweed than do the much larger hazard areas.

The work at the Range Station near Barnhart gave results showing an absence for the most part of bitterweed in the pastures not subjected to continuous grazing and its presence in those pastures where livestock were grazed throughout the year. Late in the year there was relatively little bitterweed even in the pastures being grazed throughout the year. This situation offers an opportunity for the destruction of the present seed crop, and it is expected that this opportunity will be utilized.

Miscellaneous

Satisfactory progress was made at getting determinations of the undetermined mounted sheets at the Tracy Herbarium, and this work should be completed this coming year.

A great amount of time was given to bringing up to date the presentation of data obtained in range studies within the past several years, and the same is well along on the way to completion.

The one article published was entitled, "NOTES ON TEXAS PLANTS." This was published in the December issue of the botanical magazine RHODORA.

V. L. Cory.

External Parasites of Sheep and Goats

(In cooperation with Bureau of Entomology and
Plant Quarantine, U. S. D. A.)

Goat Lice—General Conditions Affecting Completion of Program: Goat louse infestations have been normal; the sudden drop in population following shearing always interferes with control work as expected.

Climatic conditions during the past year have been, on the whole, quite favorable for goat louse control measures; however, it has seriously handicapped short nosed ox louse work and grub in the head investigations. Due to lack of material and light infestations, very little work has been done on the sheep fly, *Melophagus ovinus*.

Summary of Progress—Wetting Agents and Sulphur: With reference to goat louse control and the use of wetting agents, much progress has been made. Some of the formulae did not give results expected when lousy animals were actually dipped. The formulae that gave results which can be recommended as giving the maximum toxicity and better retention of sulphur on the skin of the animal and the mohair are 621-HPR; 629-PTY; 445-BP, 2—.5; 973-N₁HX; 983-N₁IQ; 1048-N₁SZ; 974-N₁GP; elemental sulphur plus wetting agent G₁, N₁, and T₁; 1160-GN₁Q; 1210-G₁DQ; 1260-G₁QW; 953-N₁GV; 1046-N₁PU, 1—2—.5; 874-N₁CZ; 1084-N₁SZ; 1049-N₁PX; 1060-N₁QW; 1054-N₁PT₁; 699-T₁Q; and 424-P. Nineteen other formulae were closed as second choice because at the strength of 2 pounds of wettable sulphur in 100 gallons of water they either did not quite kill all the lice or had other undesirable features. These second choice formulae would, however, no doubt, kill all lice at full strength; i. e., 10 pounds sulphur in 100 gallons of water. Twenty-nine other formulae were actually discarded because they fell far below the M.L.D., and in fact some of the formulae either did not kill at all or only killed 2 per cent to 99 per cent of all lice present. This shows that just because elemental 325 mesh sulphur is wettable does not always mean it will kill the lice. It was also discovered that in every case except one there was deposited on the skin a fair amount to a very heavy amount of the sulphur and this sulphur was well retained; whereas, it was not well retained on the goats where the discard formulae were used. All this work was carried out in artificial alkali water consisting of sodium and magnesium sulphate and gypsum water.

All of the first choice formulae were found equal to or better than the commercial wettable sulphurs on the market.

Short Nosed Ox Louse—*Haematopinus eurysternus* (Nitzsch): It has been shown that to date approximately 7,000 head of cattle have been successfully dipped in the sulphur-cube (5 per cent rotenone) dips for the control of the blood-sucking short nosed ox louse, *Haematopinus eurysternus*, with only one exception; and that was where a herd of cattle were dipped on the 14-day interval basis before the egg hatching period was known. The greatest interval between dippings is not known.

Persons responsible for this work: O. G. Babcock, Associate Entomologist, with cooperation of County Agent Jno. O. Stovall, Canadian, Texas, District Agents, and Extension Department of the Texas A. & M. College; S. W. Clark, and Dr. I. B. Boughton.

Sulphur Feeding Tests: This is a cooperative experiment between the U. S. Bureau of Entomology and Plant Quarantine, Texas Experiment Station, and the Texas Gulf Sulphur Company (miners of sulphur). The parties responsible for the work are O. G. Babcock and Dr. I. B. Boughton.

Several animals, sheep and goats, were placed in pens, both checks and sulphur fed. Two lots, checks and sulphur fed lousy animals, were placed in dark stalls for three months, then removed to pens in the sunlight. All sulphur fed animals are being *given daily 5 grams* of pure elemental sulphur for every 100 pounds of live animal weight. To date all animals are still lousy. Three calves died; one from sulphur poisoning, one from a brain disease, and one of unknown cause.

The louse population has gone down on all checks and sulphur fed animals due mainly to a thickening of the skin and a rough scaly skin. These animals have now been in the test over a five months period. Tables were not completed in time for the last quarterly report, but are now being copied for the annual report.

Aging of Sulphur—Wetting Agent Mixtures: Thirty-seven sulphur-wetting agent formulae were examined and closed out. These tests have been running from one year two months and 29 days to two years nine months and 36 days. The object was to gain some idea as to whether the wetting agents would break down when in contact with the sulphur or not. It was discovered that the wetting agents did not deteriorate. It was discovered, however, that in some cases where a liquid or semi-liquid wetting agent was used, the sulphur remained semi-dry. One formulae, 169 FH, turned to large hard lumps, and was very undesirable. Aging was a detriment in this case. On the whole a dry powder wetting agent is far better to mix with elemental sulphur than a liquid agent. The results indicate that aging will not effect most of the wetting agents, especially the powders when mixed with sulphur.

Oestrus ovis—Grub in the Head: Owing to lack of animals, no control work was carried out with the grub in the head of sheep and goats until the fall of 1939. At this time thirty-eight sheep and goats were treated, killed, and post-mortemed for results. Twenty-three chemicals were used. One that was formerly thought very promising was found to be very poisonous through absorption by nasal membranes and lungs. Only three of the chemicals tested gave good control, but one of these proved very poisonous. Ten of the animals were found not to be infested.

Treatment of *Oestrus ovis* larvae in petri dishes indicated many promising oestricides, but when the animal is treated the problem is greatly

complicated. This method, however, showed up three chemicals as killing first instar larvae, ten as killing second instars, and ten to eleven killing third instars.

Miscellaneous: Extracts of two species of poisonous weeds were preliminarily tested; one of them, the creosote bush (*Covillea tridentata*) indicated promise as a new insecticide.

Several head of sheep and goats were dipped in several commercial dips and wettable sulphur dips; the fleeces to be scoured out at the Texas A. & M. Scouring Plant when it starts operation again. The object is to compare and determine the effect of different dips on animal fibers.

Sulphur Dips: The formulae giving the most severe fluffy precipitate needs to be tested by actually dipping lousy animals, also some odds and ends need to be cleaned up.

New Dips: Further work needs to be done with the creosote bush dips, as a follow-up on two promising tests already made.

Short Nosed Cattle Louse: It is of utmost importance to know the range of the minimum to maximum dipping interval. This is now being worked out.

Melophagus Ovinus: Life history of *Melophagus ovinus* needs to be checked, but this work could better be done in Wyoming or Ohio or some other suitable northern state. The same is true for the dipping. One local dipping test is under way, but not completed.

All of the projects now under way need to be continued, owing to the great economic importance of this work to the ranchmen throughout the United States. Any improvement made is well worth the effort.

The goat louse work and the short nosed ox louse work has a direct bearing upon all kinds of louse work that may in the future come up, as well as many other parasites.

O. G. Babcock.

SUBSTATION NO. 15, WESLACO

This substation is located in the Lower Rio Grande Valley near Weslaco, Texas. The farm consists of one hundred acres of improved land, lying about midway between the cities of Weslaco and Mercedes on the main Valley highway. The four counties forming the southernmost part of the State are served by the Valley station. Of these counties, Hidalgo ranks first in the United States in acreage planted to grapefruit. It also ranks near the top in cabbage and tomato production, while Cameron County ranks second in potato production and very near the top in cabbage and tomato production. Willacy County ranks high as an onion producing

region, and with the development of facilities for irrigation, will become increasingly important in the production of citrus fruits, vegetables, cotton, and feed crops. The rapid expansion of the canning and processing industries in the Lower Valley region has increased the demand for information relating to such subjects as crop adaptability, limiting factors in crop production, plant nutrition, and the control of insect pests and diseases.

Experiments with Citrus Fruits

Accumulated experience dealing with the production of citrus fruit in the Lower Rio Grande Valley during the past 16 years emphasizes the importance of such problems as variety adaptability, deterioration diseases, nutrition, and faulty cultural practices that may have a profound effect on the health and productive capacity of orchard trees.

Orchard Reclamation Studies: Orchard studies conducted during the past six years in a decadent grapefruit orchard on alkaline, saline soil emphasize the importance of nitrogen and bulky organic matter in rejuvenating aged trees. Sulfur and minor elements contained in the crude material, copperas, were also found to be helpful in improving the condition and yielding capacity of salt-starved trees. In many old orchards the stand of sound trees is so poor that the expense involved in rejuvenating the good trees is not justified.

W. H. Friend.

Variety Adaptability Tests: Since it is now quite obvious that the acreage planted to grapefruit is much too large, grower interest is centering on oranges and other types of citrus that are more likely to be salable in the future. Orange varieties of the Joppa, Texas Navel, and Early Seedless Valencia type are being recommended because these varieties ripen relatively early but remain in usable condition late into the Valencia orange season. The Meyer lemon is still worthy of consideration, as fruit of this variety brought the highest market price paid during the 1939-40 season, and there is no cold hazard involved in producing a crop.

There are many fine novelty fruits of the Tangelo type in the station collection, but these are not being recommended except for home use or local markets.

W. H. Friend.

Citrus Breeding: Interspecific and intervarietal crosses were made involving several kinds and varieties of citrus. The following crosses were successful: Hamlin orange crossed with Joppa orange, Valencia orange crossed with Hamlin orange, Ruby grapefruit crossed with Little River grapefruit, and Parson Brown orange crossed with Meyer lemon. Seedlings growing from crosses of previous seasons are: Hamlin orange x Chamoudi orange, Thornton tangelo x Ruby grapefruit, Thornton tangelo x Valencia orange, Thornton tangelo selfed, Texas Navel orange x Meyer

lemon, Valencia orange x Meyer lemon, Temple orange selfed, Ruby orange x Meyer lemon, Thornton tangelo x Clementine tangerine, Thornton tangelo x Pink Marsh grapefruit, and Valencia orange selfed. None of these seedlings are of bearing age.

A pollen germination test was made with Duncan grapefruit pollen. The pollen was introduced into separate Petri dishes containing 5 per cent sucrose agar. Plates were made daily and germination readings were taken at the end of 22 hours. Only those cells containing protoplasm were counted, and the per cent germination was found to be 76 for fresh pollen, 57 for five-day-old pollen, 2 for ten-day-old pollen, and 0 for eleven-day-old pollen. Evidently fresh pollen should be used for citrus crosses for maximum efficiency.

Determination of the viability of citrus pollen was made with the following results: Duncan grapefruit 89 per cent, Foster grapefruit 88 per cent, Marsh grapefruit 16 per cent, Little River grapefruit 15 per cent, Ruby grapefruit 16 per cent, Joppa orange 62 per cent, Valencia orange 35 per cent, Hamlin orange 77 per cent, Pineapple orange 77 per cent, Temple orange 81 per cent, Meyer lemon 83 per cent, Thornless Mexican lime 62 per cent, and Thornton tangelo 93 per cent. Generally speaking, the low viability of the seedless grapefruit varieties accounts in part for their seedlessness. The above information will be valuable in choosing pollen parents for future crosses.

J. F. Wood.

Citrus Orchard Heating: Large capacity oil heaters were placed on approximately 450 acres of orchard containing grapefruit, oranges, and lemons on the property of Engelman Gardens, Inc. Thirty-six thermometer stands were erected in advantageous locations throughout the planting.

Weather conditions did not necessitate firing the heaters. This made the third consecutive year this test could not be conducted.

J. F. Wood.

Citrus Variety Descriptions: Detailed physical measurements, such as diameter and depth of fruit, stem and blossom-end shape, rind thickness, number of segments, regularity of segments, number of seeds, and volume of juice were made on the Eureka lemon and the Mexican lime. The same type of data have been obtained on Perrine and Meyer lemons; Hamlin, Parson Brown, Pineapple, Ruby, Joppa, Homossasa, Temple, Valencia, Washington Navel, Texas Navel, and Bahia Navel oranges; Marsh Seedless, Little River Seedless, Thompson, Thompson Blush, Duncan, McCarty, and Foster grapefruit; and on Dancy, Clementine, and Willow Leaf tangerines, and the Owari Satsuma.

J. F. Wood.

Citrus Maturity Investigations: The effect on grapefruit maturity of a growth promoting substance containing fluorescein dye was studied. The material was introduced into the irrigation water at the rate of six

pounds per acre in August, 1939. Maturity tests were made at two week intervals during September and October of 1939. The differences in fruit maturity between the treated and untreated plats was so slight as to be negligible.

J. F. Wood.

Rootstock Tests: The better strains of sour orange are so well adapted to conditions existing in this region that there is no reason for considering other understocks except for special purposes. Since Cleopatra mandarin seems to increase the size of the scion variety, white Citrange stock has the opposite effect, Cleopatra stock is being investigated as a stock for such varieties as Hamlin and Ruby Red grapefruit, while Citranges are being tested as stocks for oversized types of navel oranges.

W. H. Friend.

Fertilizer Tests: The accumulated results of fertilizer tests conducted in grapefruit orchards ranging in age from 8 to 19 years justify the conclusion that nitrogen concentrates are the most reliable materials for fertilizing orchard soils. In a block of 19 year old trees, the results obtained with comparable amounts of cyanamid, sulfate of ammonia, and 16-20 ammonium phosphate were very similar but definitely superior to results secured with equivalent values in complete fertilizers (5-15-5 or 10-30-10). In a one year test on heavily fruited, 8 year old grapefruit trees, urea was definitely superior to calcium nitrate as measured by degree of chlorosis occurring during the fall season.

W. H. Friend.

Progeny Studies: Accumulated data on two blocks of 8 year old grapefruit trees which were propagated from parent trees of variable productive capacity, show that the tendency of a budded tree to produce abundant crops is not necessarily due to heritable factors transmitted to the budding. The bearing habits of a budded tree are the results of a combined influence of both scion variety and rootstock. Understocks should, therefore, be selected with as much care as that given buds used for propagation purposes.

W. H. Friend.

Girdling Tests: Unfruitful strains of navel orange can be made to produce abundant crops by girdling during the early part of the blossoming season. Girdling must be accompanied by generous fertilization or the health of the trees is likely to be impaired.

W. H. Friend.

Wound Protectant Studies: Further studies were conducted with anti-septic wound dressings designed to protect tree wounds from infection and weathering. These studies have not been completed, but it is evident that tung oil improves the weathering qualities of wound paints. It is not safe to bolster the phenol content of wound dressings unless the user

is in possession of the true facts concerning the phenol contents of the other ingredients of the paint.

W. H. Friend.

Citrus Diseases

Citrus Stem-end Rot Control: During the period of greatest susceptibility of lemons to *Diplodia* stem-end rot, from August to November, inclusive, some of the most promising of the materials used in previous years and some additional chemicals were tested. Outstanding in efficiency, even in comparison with hot borax solution dips, were sodium ethyl mercuri thiosalicylate (Merthiolate Lilly) and sodium p-ethyl mercuri thiophenyl-sulfonate (Sulfo-merthiolate Lilly). Stem-end treatments at 1 to 1,000 and 1 to 5,000 concentrations by a "stamp pad" method improvised during the tests gave practically perfect control over 2 and 3-week incubation periods during which checks showed 72 and 84 per cent decay. Repeated experiments later in the season showed equally good results. Complete fruit-dip treatments for 2 minutes at 1 to 10,000 concentrations with both chemicals gave 99 to 100 per cent control in late season tests while checks were showing 27 and 35 per cent decayed after a 3-week incubation period. The striking control obtained with both methods was undoubtedly due to both the high disinfectant properties of the chemicals and their excellent penetrating powers. While these promising chemicals are rather expensive, costs of treatments are almost negligible in comparison with losses that are frequently encountered in shipments during a period of high incidence of the disease.

G. H. Godfrey.

Citrus Chlorosis: In confirmation of previously reported results, sulfur applied at the rate of 25 pounds per tree in 10-inch deep holes around the bases of chlorotic citrus trees in January, 1938, brought about striking recovery, as manifested by observations made in November, 1939. Grapefruit trees that had originally shown about 40 per cent of the new growth badly chlorotic were improved to the point of practical freedom from chlorosis. Orange trees likewise were improved from about 44 per cent chlorotic to practically complete cure. Non-treated check trees remained practically at a standstill insofar as chlorotic appearance was concerned.

Treatments in which various mineral salts, specifically the sulfates of Fe, Zn, Mn, Mg (5 pounds per tree) and Cu (1½ pounds per tree) were thoroughly mixed with 20 pounds of sulfur flour per tree did not show any improvement over the straight sulfur. In the case of Cu the chlorosis appeared actually to have increased. The disinfectant action of the copper sulfate may be presumed to have been sufficient to have inhibited the oxidation of the sulfur to acid, thus eliminating the possibility of change to soluble form of the native minor elements necessary for healthy tree growth.

G. H. Godfrey.

Citrus Insects

Rust Mite Population Studies: Rust mite studies were continued throughout the year. Infestations were unusually high during March and April. Frequent but light showers during March greatly complicated control of these pests during the spring season.

T. B. Randolph.

Scale Insect Control: Field tests with Dinitro-O-Cyclohexylphenol (1 per cent) were conducted on lemons against scale crawlers. No scale crawler kill was observed on any of the treated trees. Leaves were not damaged by application of one pound of the 1 per cent dust per tree.

T. B. Randolph.

Experiments with Subtropical Fruits

Date Variety Adaptability Studies: There are 196 established palms of 25 varieties on the station. Of this number, 76 are from Iraq, 2 from Arizona, and the remainder from California groves.

The following varieties are represented in the station collection: Maktoom, Halawy, Thoory, Zahidi, Saidi, Safraia, Dubaini, Hayany, Deglet Noor, Tazizoot, Okht Fteemy, Khadrawy, Sukkar Nabat, Kustawy, Tadala, Amir Haj, Khatuni, Jaffary, Bedraya, Khasab, Sayer, Ashrasi, Bahrab, Dayri, and Braim.

J. F. Wood.

Date Propagation and Fruiting: Five offshoots were given to a co-operator in the Laredo area to replace those which failed to live last season.

Eighty-four fruit bunches were borne on 24 palms of the following ten varieties in 1939; Maktoom, Halawy, Amir Haj, Tazizoot, Bedraya, Khadrawy, Khasab, Deglet Noor, Ashrasi, and Dayri. The set of fruit was not as satisfactory as in previous seasons. The Maktoom, Halawy, and Amir Haj varieties ripened without an appreciable amount of souring. The quality of the Maktoom and Amir Haj fruit was especially good.

J. F. Wood.

Papaya Breeding: Crosses between families and sib-pollinations within families of several strains of papayas were made. The original sib-pollinated seed were obtained from the U. S. D. A. Subtropical Fruit Research Laboratory at Orlando, Florida. Descriptions were made of a typical fruit from each plant used in the breeding work. Data as to fruit weight, length, diameter, flesh thickness, odor, and flavor were recorded. Sib-pollinations and crosses were made involving three families of the Bronson strain and one family each of the Graham, Betty, Florida, and Orlando strains. The quality of the Graham fruit was considered superior to the others this season.

J. F. Wood.

Adaptability Tests

Papaya: The perfection of a method of producing reliable seed of this monoecious plant has stimulated interest in the commercial production of this fine subtropical fruit. Plants grown from sib-pollinated seed come remarkably true to type, and strains such as Graham and Fairchild have superior dessert and shipping quality.

A number of excellent products are made from papayas, and the fresh fruit is becoming increasingly popular.

The crop can be handled as an annual or the trunks may be protected from cold by banking so as to make the roots perennial.

W. H. Friend.

Adaptability Studies

Avocado: Since it is now a proven fact that a large percentage of seedling avocados of the West Indian type will thrive in the calcareous, saline soils of this region, the problem of establishing a commercial industry resolves itself into one of commercializing the propagation of cold resistant varieties on salt resistant, West Indian understocks. There is evidence that this combination will work satisfactorily in this region. Propagation studies with the Lula and Gottfried varieties are now under way at the Station.

W. H. Friend.

Experiments with Other Fruit Crops

Grapes: After extensive studies over a long period of years, it now seems fairly certain that the Valley is a poor grape producing region. Lack of sufficient cold periods to induce regular fruiting appears to be the most logical explanation of grape failure in the Lower Valley.

W. H. Friend.

Strawberries: The growing of strawberries as an annual crop appears to have commercial possibilities in the Valley provided strong slips can be secured for the establishment of the plantations early in October.

It is seldom profitable to summer over strawberry plantations in this region except where sprinkler type irrigation is available.

Of the new strawberry varieties developed at the Winter Haven Experiment Station, Texas No. 28 deserves special mention because of its earliness, productive capacity, and fine dessert quality; while Texas No. 21 is a variety of outstanding vigor, enormous yields, and exceptional shipping quality. Narcissa is an extra early variety of dark color and fine quality but falls short in production. Plants of the Banner variety equal Texas No. 21 in size and vigor but failed to produce a single berry.

Applying insoluble phosphate fertilizers about the roots of strawberry plants at transplanting time increased yields 19 per cent.

W. H. Friend.

Experiments with Vegetable Crops

Since it is not practicable to conduct research work with all crops produced in the Valley, it seemed desirable to concentrate on the solution of problems relating to the three most important vegetable crops grown by Valley farmers.

Cabbage Variety Tests: Shippers of green cabbage prefer small, compact, round headed varieties of the Midseason Market-Copenhagen type, but growers are reluctant to change from vigorous varieties of the All Head-Flat Dutch type that will produce good yields, even under adverse weather conditions. Yields during the past season ranged from 5 tons per acre for Round Red Dutch to 18 tons for All Head. Early maturing varieties such as Round Dutch yielded only 9.7 tons per acre, but mid-season types such as Midseason Market produced 17.2 tons per acre, and the heads were smaller in size and more compact than those of the All Head or Flat Dutch varieties.

W. H. Friend.

Cabbage Spacing Tests: The 12 inch by 36 inch spacing of cabbage plants increased yields only 0.7 tons per acre in the case of extremely dwarfed varieties such as Round Dutch but gave a 1.9 ton increase in the case of a larger variety like Midseason Market. The usual spacing for small sized plants is 14 by 36 inches.

W. H. Friend.

Cabbage Variety Tests in Cameron County: Of the 19 varieties and strains grown near Harlingen during the winter of 1938-39, five produced more than ten tons per acre without fertilizer. The yields per acre of these five varieties and strains were: Glory of Enkhuizen 12.8 tons, Midseason Market 12.2 tons, Copenhagen Market 12 tons, All Head Early 10.75 tons and a second strain of Midseason Market 10.75 tons. The lowest yielding variety was Danish Roundhead with 3.5 tons per acre.

Two cabbage variety trials were planted in the fall of 1939. Each consisted of 16 varieties and strains in 1/100 acre plats with four replications. One test was planted near Harlingen, and the other near Los Fresnos.

J. F. Wood.

Cabbage Fertilizer Tests: This test was conducted near Harlingen with 7 fertilizer treatments. The treatments consisted of three sources of nitrogen (cyanamid, sulfate of ammonia, and calcium nitrate) and 8-16-8 fertilizer with and without an organic base and an 8-16-0 fertilizer with and without minor elements. All three of the nitrogen carriers depressed the yields. They were applied at the rate of 400 pounds per acre in a single application which is believed to have caused an unfavorable condition by unbalancing the other soil nutrients. The check plat yielded 11.5 tons per acre. The highest yield was on the 8-16-8 plats with 15.25 tons per acre. The lowest yield was on the calcium nitrate plats with 4.66 tons per acre.

Two cabbage fertilizer tests similar to that above were planted during the fall of 1939. The nitrogen carriers were applied in three equal applications. One test was located near Harlingen and the other near Los Fresnos.

J. F. Wood.

Cabbage Green Manuring Tests: Cabbage grown on plats which produced a soil improving crop of sweet sorghum during 1938 will outyield that grown on plats which produces *Crotalaria juncea* during that same year. Cotton grown on these plats during the summer of 1939 reacted differently, as the cotton following *Crotalaria* outyielded that produced on undecomposed sorghum stubble by 80 pounds of lint cotton per acre. The sorghum residue had thoroughly decomposed at the time the cabbage crop was planted.

W. H. Friend.

Cabbage Seed Treatments for Black Rot Control: In view of the consistent reductions in seed germination brought about by the standard 30 minute mercury bichloride treatment, seed treatment experiments were continued in the 1939 cabbage planting season. Outstandingly good from the point of view of lack of injury were sodium ethyl mercuri thiosalicylate (Merthiolate Lilly) treatments at 1 to 1,000 and 1 to 5,000 concentrations in 1 and even 5 minute soaks. Owing to continued environmental conditions unfavorable for the disease, black rot did not appear in the seedbeds even in the non-treated control rows. In fact in the 1939-40 season, black rot was conspicuously low in incidence in the Lower Valley, in striking contrast with the situation the year before.

G. H. Godfrey.

Control of Worm on Cabbage: In toxicity tests upon *Autographa brassicae* (Riley), cabbage looper; and *Plutella maculipennis* (Curtis), diamond back, a cube-sticker spreader (3 lbs.-4 oz.-50 gal.) gave the best control of the diamond back larvae. Three pounds of Cube (5% rotenone) and four ounces of sticker spreader was used to 50 gal. of water. Straight calcium arsenate as a dust gave the next best control of diamond back moth larvae. Paris green-Talc (10-90) with one per cent spreader-sticker; Cube (5 per cent rotenone) Talc (12.5-87.5); and calcium arsenate as a dust all gave a high degree of control of loopers.

T. B. Randolph.

Control of White Grub on Cabbage and Other Crops: Infestation in cabbage seed beds was too low to obtain data relating to control, but no plant injuries were caused by the application of Naphthalene-Superphosphate (20-80); Naphthalene-Paradichlorobenzene-Superphosphate (10-10-80) at the rate of 400 pounds per acre, or by the application of Naphthalene-Peat-moss (20-80); and Paradichlorobenzene-Peat-moss (50-50) at the rate of 120 pounds per acre.

On Parsley, applications of Naphthalene Superphosphate (20-80); Naphthalene-Paradichlorobenzene-Superphosphate (10-10-80); and Cyanamid 400

pounds per acre, or Naphthalene-Peat-moss (50-50); Paradichlorobenzene-Peat-moss (50-50) 200 pounds per acre, or Naphthalene-Sulphur (60-40) 460 pounds per acre, or Arsenate of Lead 30 pounds per acre, or Kerosene; Kerosene-Paradichlorobenzene-water ($\frac{1}{2}$ gal.-5 lb. 100 gal.) one hundred gallons per acre, or Fuel oil 200 gallons per acre did not affect germination of the seed or retard development of the plants.

T. B. Randolph; P. T. Riherd.

Tomato Variety Test: The spring of 1939 afforded an excellent opportunity to study the effect of hot weather at blossoming time on the yield of early tomatoes. Break O'Day was the outstanding variety in the 1939 tests, and plats planted to this variety yielded 4,000 pounds per acre of marketable fruit before varieties like Rutgers and Marglobe had produced as much as 500 pounds per acre. When all factors are considered, Stokesdale appears to be the most reliable variety of tomato for use on the sandy loam soils.

W. H. Friend.

Tomato Transplanting Tests: Since all fall grown tomatoes must be transplanted, it is highly important that this operation be performed so as to cause as little setback as possible. Care in pulling and handling the plants, setting in damp soil, and prompt watering after setting were found to increase yields of early fall tomatoes. Applying damp peat-moss and 32% superphosphate (2 ounces per hill) about the roots at transplanting time also increased the yield of early fruit. Bone meal, superphosphate, and cotton seed flour were used alone as hole applications and in combination with moist peat-moss. In another test, peat-moss soaked in nutrient solution gave marked increases in yield when applied about the roots of tomato plants at transplanting time.

W. H. Friend.

Tomato Pruning: The pruning of tomato plants to induce suckering early in the growth period tended to reduce yields of early fruit on all varieties included in the spring trials.

W. H. Friend.

Tomato Fertilizer Tests: During the 1939 season, the most profitable increases were secured by using 600 pounds per acre of a 6-18-0 fertilizer. Since both phosphorus and nitrogen appear to be highly important in the nutrition of tomato plants, a mixture composed of equal parts of 16-20-0 and 32 per cent superphosphate is being recommended for tomatoes and related crops. The amount of the mixture should range around 500 pounds on soils which have been under cultivation for many years.

Spray applications of manganese or magnesium, applied three times per season in conjunction with wettable sulfur and basic copper sprays, failed to give significant increases in yield. Caustic sprays, such as standard Bordeaux, appeared to be especially damaging to tomatoes and potatoes during the exceptionally dry spring season of 1939.

W. H. Friend.

Tomato Fertilizer Tests in Cameron County: Sulfate of ammonia alone, 32 per cent acid phosphate, 8-16-8 with and without an organic base, and an 8-16-0 with and without minor elements were the treatments used. Tests were conducted near Harlingen, Los Fresnos, and Brownsville. The Rutgers variety was used. There were no significant differences in yield in any of the tests. Growing conditions were poor in all of the tests. Excessive rainfall decreased the stand at Harlingen, cutworm damage necessitated the transplanting of all the plats at Los Fresnos, and an overflow from the river inundated the test at Brownsville.

J. F. Wood.

Tomato Variety Tests in Cameron County: Fifteen varieties and strains of tomatoes were grown near Harlingen and near Brownsville. The Brownsville test was inundated by an overflow of the river after the first harvest. Yields from the test at Harlingen were rather low due to the poor growing conditions. Grothen's Globe, California Special Early, Pritchard, Valiant, and Bonny Best were the highest yielding sorts. Break O'Day, Stokesdale, and Rutgers were next in yield.

J. F. Wood.

Tomato Breeding: First generation plants of Master Marglobe crossed with San Marzano and Rutgers crossed with Stokesdale were raised. The following crosses were made in the fall of 1939: Rutgers crossed with Pearson, Pearson crossed with Pritchard, J. T. D. crossed with Pritchard, Break O'Day crossed with Stokesdale, and Break O'Day crossed with J. T. D. A study of hybrid vigor will be made to determine if such seed can be produced for commercial use.

J. F. Wood.

Tomato Early Blight Dusting Tests: A Station planting of tomatoes developed a serious outbreak of early blight (*Alternaria solani*) late in the season. By way of a preliminary test to determine effects of various insoluble coppers on the foliage and possibly on disease control, 3 of such materials and 25-25-50 copper-lime dust (with sulfur as carrier) were applied as dusts on 5 replicated plats each, with an equal number of non-treated control plats, all arranged in random Latin Square order. At the time of the applications, leaf spotting was already abundant. Three weeks later the check plants showed an average of 43 spots per leaf. The number ranged from 20 to 23.8 spots on treated plats, all significantly lower. The copper-lime-sulfur mixture, with 20 spots per leaf, was barely significantly lower than Cupro K-sulfur 10-90 and Tennessee-copper-sulfur 15-85, but not significantly lower than Cuprocide GA-sulfur 5-95. Thus, with only the single application of fungicides, definite value in disease control was indicated. No visible injury occurred in any case.

G. H. Godfrey.

Tomato Fruit Worm Control: Straight calcium arsenate gave a slightly better control of the tomato fruit worm than did the following combina-

tions: Copper Oxychloride-Calcium arsenate (12-88); copper oxychloride-sulfur-calcium arsenate (12-38-50); Derris-sulfur-calcium arsenate (10-78-12); Copper oxychloride-arsenate of lead-sticker spreader (5 lb.-4 lb.-3 oz.); copper oxychloride-sulfur (12-88); Copper oxychloride-derris-sticker spreader (5 lb.-5 lb.-3 oz.)

T. B. Randolph.

Control of the Garden Flea Hopper on Tomatoes: Promising results were secured in the control of this important pest of tomatoes by means of a pyrethrum-sulfur dust containing two-tenths of one per cent pyrethrins; also with a tobacco dust containing 3% nicotine. Less success with other dusts were in the order listed. Derris-Pyrethrum-Sulfur (10-10-80), Tobacco dust 3% nicotine-Sulfur (50-50), Derris-Sulfur (15-85), and Sulfur.

T. B. Randolph.

Potato Variety Test: During the spring season, potatoes of the Chippewa and Katahdin varieties outyielded those of the Triumph variety to a marked degree.

The fall season was especially favorable for potatoes, and the crop grown from throwbacks and unmerchantable grades from the spring crop produced exceptionally good yields: 336 bushels per acre for Chippewa, 264 bushels for Katahdin, 254 bushels for Triumph, and only 113 bushels for Masaba. Chippewa is an outstanding variety that should be extensively planted in the Valley and in other parts of South Texas.

W. H. Friend.

Potato Fertilizer Tests: Plats which received 6-18-6 fertilizer at the rate of 600 pounds per acre produced the highest yields of marketable tubers. Due to a severe and unprecedented epidemic of thrips, the crop on all plats was greatly reduced. Spray applications of manganese or magnesium, in conjunction with the blight control spray, had no consistent effect on yields and seemed to accentuate the damage caused by thrips.

W. H. Friend.

Potato Fertilizer Tests in Cameron County: Rather extensive tests were conducted on river bottom land and upland near Brownsville with Bliss Triumph. Sulfate of ammonia alone, 32 per cent acid phosphate, 8-16-8 with and without an organic base and 8-16-0 with and without minor elements were the treatments used. No significant differences in yield over untreated plats was found. The untreated plats on river bottom soil yielded 131 bushels per acre of marketable tomatoes whereas the yield on the untreated plats on the upland soil was only 68 bushels per acre.

J. F. Wood.

Potato Irrigation Test in Cameron County: This test was conducted on rich bottom land which received a good rain just prior to planting; thus all plats were considered as having been pre-irrigated. One plat received no further water, one plat was irrigated once by gravity, one plat twice by

gravity, one plat once with a portable system of irrigation, and one plat twice with the overhead system. There was no significant difference between the treated plats and check plat. There was, however, an indication that the more moisture available to the plants, the higher the yield. There was a general indication that more frequent irrigation should have been applied in all cases. The physical state of the top soil was better where overhead irrigation was used.

J. F. Wood.

Potato Minor Element Spray Test in Cameron County: This test was conducted on potatoes grown on river bottom land near Brownsville. Wettable sulfur with additions of magnesium, manganese, and iron in various combinations was applied two different times to the potato vines at the time the first tubers were being formed. The applications were two weeks apart and were made with a hand-powered sprayer. In this test the differences in yield were so slight as to be negligible. Slight to moderate burning of the foliage was caused by some of the sprays.

J. F. Wood.

Potato Strain Test in Cameron County: Forty-one strains of Bliss Triumph from North Dakota, Nebraska, and Minnesota and one strain of the Warba variety were grown on a cooperator's farm. The seed lots were small, and single row plats were used, in most cases, without replication. The yields ranged from 109 bushels to 170 bushels of marketable potatoes per acre. Since it is sometimes difficult for growers to obtain identically the same strain of seed as that from which a sample is furnished, the reliability and value of this type of test is questionable.

J. F. Wood.

Potato Early and Late Blight Spraying Tests in Cameron County: Directly contrary to the situation a year before, the 1939 spring potato crop in Lower Rio Grande Valley was completely free from late blight (*Alternaria solani*). A comprehensive spraying experiment directed toward the control of these diseases, therefore, gave no results insofar as disease control was concerned. In a series of 18 replicated plats, Bordeaux 5-5-50 reduced yields, as compared with controls, 9 bushels to the acre, which was a statistically significant amount. Bordeaux 5-2-50 with dolomitic lime instead of calcium lime, Bordeaux 5-2-50 with a spreader-sticker added, a 2-1-50 Bordeaux with 3 pounds wettable sulfur added, a basic copper sulfate (Tennessee copper) 2½ to 50, and Copper Hydro 40, 5, to 50, all gave significant increases in yield over the standard 5-5-50 Bordeaux spray.

G. H. Godfrey.

Potato Scab Control with Band Applications of Sulfur: From both spring and fall plantings of potatoes in scab-infested fields, the indications are that band applications properly placed with reference to the developing tubers will prove to be a practicable means of controlling scab under Rio

Grande Valley conditions. New tubers formed in the zone of soil above the layer of sulfur are apt to be beyond its influence and scab may appear. In a few cases where tubers were formed directly in contact with the sulfur, scab was lacking, but there was a distinct sulfur injury manifest by regions of increased red color on the skin, and even by sunken lesions. The placement of the acidifying material in a band above the seed-piece level would appear to be a promising procedure. The use of sulfur-compost, already acid at the time of application, so placed, is indicated as being a means of procuring a desired range of acidity at just the right time and in the right location for best results. In a 1939 fall planting of Katahdin potatoes, 700 pounds per acre of sulfur compost ($\frac{1}{2}$ sulfur) gave 32 pounds increase (37.0 per cent) of marketable potatoes over the check in a 1/100 acre plat. At 400 pounds per acre of the sulfur compost, an increase of 21 pounds or 24.5 per cent was obtained.

G. H. Godfrey and Herbert Rich.

Potato Psyllid Control: Satisfactory control of a light infestation of potato psyllids was obtained with a lime-sulfur spray (1 per cent) supplemented with six ounces of nicotine sulfate to 50 gallons of water; however there was a severe burning of foliage, believed to be due to residue from a previous application of Bordeaux mixture.

T. B. Randolph.

Bean and Pea Varieties for Canning and Quick-Freezing: In the fall of 1939, twelve varieties of snap beans and 12 varieties of English peas were grown. No yield data were obtained due to poor growing conditions. Notes were taken on pod length, color, average weight, and tenderness.

J. F. Wood.

Beet Web Worm Control: Infestation was too low to obtain any data relating to control; however, two applications of a 1 per cent Dinitro-O-Cyclohexylphenol caused severe foliage injury. Approximately fifty per cent of the plants receiving this treatment died from the chemical burn.

T. B. Randolph and P. T. Riherd.

Experiments with Agronomic Crops

The expansion of the livestock industry has increased the demand for information pertaining to feed and forage crops. Also, the invasion of the Valley by the pink boll worm has centered grower interest on cotton varieties that will produce abundantly and mature early, and on money crops that may take the place of cotton in the farm scheme.

Cotton Variety Tests: All varieties produced good yields of lint during the 1939 season, but Stoneville 2B and Washington were outstanding in yield and quality of staple. Stoneville 2B produced slightly more than 800 pounds of lint per acre that showed a staple length of $1\frac{1}{8}$ inches. This yield was 230 pounds per acre better than the lint yield for three strains of Acala cotton. Cotton varieties such as Stoneville 2B, Delfos, Misdell-7, and

D. P. L.-11A are best for use on the irrigated, sandy loam soils of this region. It appears that the Acala cottons may have a place on heavier types of land that are dry farmed.

W. H. Friend.

Rotation Experiments with Cotton: Delfos cotton planted after the incorporation of a crop of *Crotalaria juncea* during the winter season of 1938-39 produced 930 pounds of lint per acre, compared with a yield of approximately 850 pounds per acre where cotton was grown on sweet sorghum stubble that was treated with 100 pounds per acre of calcium nitrate six weeks prior to the time the cotton was planted. During the previous season, cyanamid (300 pounds per acre) applied to sweet sorghum stubble that was incorporated with the soil several months prior to cotton planting time, produced outstanding increases in yield (50 per cent).

In another test, cotton following a winter cover crop of Hubam out-yielded that grown on land which produced winter oats by 207 pounds of lint per acre, where neither crop residue was treated to hasten decomposition. Root rot disease was not a factor on either block.

W. H. Friend.

Cotton Topping Studies: Due to excessive summer precipitation, cotton topping should have hastened maturity and increased yields of cotton. The test conducted with Delfos 531A cotton showed that topping reduced yields to a marked degree and increased the yield of early cotton by only 1 per cent. Untopped Delfos cotton in this exceptionally good block produced 1,379 pounds of lint cotton per acre that had a staple length of 1 3/16 inches and graded strict middling.

W. H. Friend.

Cotton Irrigation Tests: During the 1939 season, the cotton irrigation studies were conducted on land that grew irrigated vegetables during the winter months. The soil moisture stored up from irrigations applied to the winter crop, coupled with abundant summer rainfall, made it impossible to show significant increases from differential irrigation practiced during the growing season. It has been previously observed that cotton produces exceptionally well following winter vegetable crops that are copiously irrigated.

W. H. Friend.

Cotton Fertilizer Tests: Concentrated fertilizers such as 16-20-0 are most profitable for use on cotton, especially where cotton follows a soil depleting winter crop such as cabbage. One hundred pounds per acre, applied in the bottom of the lister furrow prior to the pre-seeding irrigation has given excellent increases in yield, but this concentrated material is not safe for use as a band application, near the seed, at planting time.

Two cooperators report excellent results from the use of one hundred pounds each of sulfate of ammonia and finely ground sulfur applied in the

water furrow prior to the pre-seeding irrigation. The cotton seed is planted in the acidified soil in the bottom of the irrigation furrows. Excellent yields were secured, and losses from root rot disease were negligible, while losses in adjoining fields ranged from 25 to 30 per cent.

W. H. Friend.

Cotton Boll Weevil Control: Calcium arsenate (1 part) sulfur (2 parts) gave a higher degree of control than a standard mixture of calcium arsenate and Paris green.

T. B. Randolph.

Thrip Control on Cotton: The best control of thrips on cotton was secured with a mixture of Paris green-Zinc Oxide-Sulfur (10-1-89). The next highest degree of control was obtained with a mixture of Derris (5% rotenone)-Sulfur-Zinc Stearate (10-89-1). No appreciable control was secured with Zinc Oxide-Sulfur-Derris (1-89-10); Zinc Stearate-Sulfur-Derris (1-89-10); or Paris green-Cottonseed Flour (10-90). None of the six mixtures used gave sufficient control of thrips to be regarded as economically practicable. Cotton seed flour seemed to act as an inhibitor to Paris green.

T. B. Randolph.

Sorghum Adaptability Tests: Thick seeded, row planted Atlas Sorgo and Hegari produced excellent yields of forage (24 to 28 tons, respectively), but the heads were stripped of grain by birds before any seeds were mature. Band planted, irrigated Dwarf Sumac Sorgo produced 19 tons per acre of forage and 1,260 pounds of threshed seed. This is an especially fine type of Sumac Sorgo for Valley planting.

W. H. Friend.

Castor-bean Adaptability Test: Plantings of six varieties of castor-beans were made on heavy saline soil and on light sandy soil that is highly productive. The beans were a complete failure on the saline soil, but most varieties produced enormous stalk growth on the good, irrigated land. Yields of shelled beans ranged from 158 to 1,689 pounds per acre.

W. H. Friend.

Winter Legumes: Hubam clover has become important as a soil improving crop, as a forage crop, and as a seed crop. The highest yields of seed (971 pounds per acre) were secured with seeding rates of 15 pounds per acre. The seed was planted in broad (2 inch) bands spaced 18 inches apart.

A planting of alkali resistant Strawberry clover seemed to be adapted to Valley conditions, but the plants are too small to be valuable, except for pasturage.

Plantings of three varieties of alfalfa were seriously damaged by leaf hopper and thrips.

Fenugreek produced abundant yields of seed and dried plant yields of 3 tons per acre.

W. H. Friend.

Flax Variety Test: Bolley's Golden produced the highest yield of any variety in the variety test (22.5 bushels per acre). Much higher yields were secured from plantings of Rio and Punjab flax planted at an earlier date. October 15th appeared to be the best planting date for irrigated flax during the 1938-39 season.

W. H. Friend.

Flax Rate of Seeding Test: Where flax was planted in 2 inch bands spaced 18 inches apart, seeding rates ranging from 12½ pounds to 50 pounds per acre gave equally good results. This flax was irrigated five times during the growing season and stooled out quite freely. Yields ranged around 30 bushels per acre.

W. H. Friend.

Oat and Barley Tests: Fulghum-Victoria rust resistant oats, developed by the Denton Station, produced a fair yield of grain before the plants were damaged by stem rust. Forage yields made when the grain was in the soft dough stage ranged around 12 tons per acre, compared with 8 tons per acre for comparable plats of Texas Red Rust Proof oats.

Barley was severely damaged by leaf and stem rust before the plants neared maturity.

W. H. Friend.

Sunn Hemp (*Crotalaria juncea*): This is one of the few species of *Crotalaria* that appears to be well adapted to all types of soil in the Valley. This rank growing legume is resistant to cotton root rot disease, is immune to rot-knot nematode, and is the only cover crop tested that will smother out nut grass. The bulky, fibrous residue from this crop decays at a fairly rapid rate and leaves the soil in fine physical condition, and greatly improved in productive capacity.

W. H. Friend.

Pigeon Peas: Hawaiian pigeon peas (*Cajanus indicus*) appears to be well adapted to conditions in this region. The plants attain a height of 8 to 10 feet and are heavily loaded with pods which are filled with speckled beans that are relished by all types of livestock, and make excellent human food. It is strictly a tropical species and is most valuable when used as a perennial browsing crop.

W. H. Friend.

Flax PasmO Disease (*Phlyctaena linicola*): In a variety trial rod row planting of 12 flax varieties planted in November 1938 and ready for harvest in May 1939, PasmO disease appeared irregularly, but it was evident that some varieties were much more free from the disease than were others. Punjab was the most severely affected, and Bolley Golden the least.

G. H. Godfrey and Herbert Rich.

Sudan Disease Resistance Studies: During the summer, a Station planting of Sudan-grass hybrids selected by the Main Station agronomists for

trial in Rio Grande Valley were observed from time to time, to check on relative resistance to rust, Helminthosporium blight, and bacterial stripe disease. The Helminthosporium blight proved to be the most serious of the leaf diseases, and several strains proved to be unfit for further propagation under Valley conditions on account of its severity. Seven strains from Leoti sorgo x Sudan crosses were clearly better than the others, three of them outstandingly so, and were designated for further planting. Helminthosporium blight, and to a somewhat less extent, bacterial stripe and rust are definite factors in the successful growing of Sudan grass for forage in the Valley farms.

G. H. Godfrey.

Experiments with Ornamental Plants

Adaptability Studies: The station collection of native ornamental plants and exotics was materially increased during 1939. Among the more desirable native plants established in the plant introduction garden were five species of acacias, *Nicotina glauca*, *Helietta parvifolia*, *Ulmus alata*, *Condalia obovata*, *Brayodendron texanum*, *Karwinski humboltiana*, and *Zanthoxylum fagara*.

Of the exotics which were acquired by the station, the following appear to be most desirable: *Bauhinia calipinia*, *Litchi chinensis*, *Delonix regia*, *Taberia argentea*, *Assonia* sp., *Ixora fulgens*, and several species of cassias and clerodendron.

Correction of Nutritional Disorders: The application of sulfur and soil correctives in circles of holes punched into the soil about the crown roots of plants has been found to be a most practicable means of correcting or preventing the occurrence of chlorosis or yellowing of lime sensitive plants. A mixture composed of 1 pound of 11-48-0 ammonium phosphate, 1 pound of finely ground sulfur, and 1 ounce of copperas (green vitriol) is sufficient for treating the larger sized shrubs. The number of holes used and their placement will depend upon the size of the plant to be treated. This treatment, when supplemented with sulfate of ammonia and 2 per cent sulphuric acid solution, is very effective in arresting the development or preventing the occurrence of cotton root rot disease.

W. H. Friend.

Chrysanthemum Root Failure Due to the Meadow Nematode, *Pratylenchus pratensis*: A condition of heavy soil infestation with this nematode, resulting in practically complete failure of plants, occurred in a florist's nursery near the Valley Experiment Station. In the summer of 1939, two adjacent beds were selected for an experiment on control; one of them was fumigated with chloropicrin according to standard methods; the other was left as a control. Outstanding control was obtained.

G. H. Godfrey.

Chlorosis of Roses and Other Plants: Chlorosis occurs as a symptom of lack of availability of certain minor elements, particularly iron, in the alka-

line soils of Lower Rio Grande Valley. Roses, gardenias, hibiscus, bougainvillea, and many other ornamental plants are affected. Experiments were conducted on the application of sulfur, sulfur compost, iron sulfate, and other materials to determine the best and most practicable remedy to be recommended to growers. Early tests with roses indicated that sulfur-compost applied in "spot" applications in holes about the base of the plant resulted in striking recovery. In a carefully conducted experiment on a large rose bed, in which several different materials were applied in crowbar holes 8 to 10 inches deep about the bases of badly chlorotic plants, a mixture consisting of $1\frac{1}{2}$ pounds sulfur compost (containing $\frac{3}{4}$ pound sulfur), 1 ounce (42 per cent N) and 2 ounces iron sulfate brought about a relatively quick response, and the best appearance of the plants two months after application. Sulfur compost and iron sulfate alone likewise brought about good recovery, as did also sulfur-urea-iron sulfate, and sulfur-urea mixtures. Outstandingly deficient in effectiveness were cyanamid (22 per cent N) with N content equivalent to that in the urea applications, and gypsum 1 pound to the plant.

Chlorosis in bougainvillea, petunia, and gardenia was likewise remedied effectively by applications of sulfur compost in spot applications about the roots. No effort was made to acidify the entire volume of soil around the plant roots.

Herbert Rich and G. H. Godfrey.

Effect of Soil Fumigants on the Germination of Seeds: The germination of snap beans and teosinte seed was not adversely affected by the following materials when applied in drills either one or two weeks prior to planting: Naphtha-Naphthalene-Miscible oil (14-1-14), Naphthalene-Sulfur-Carbon bisulfide (4-4-24), Naphtha-Naphthalene (32-2), Naphthalene-carbon bisulfide (10-22), Naphthalene-Gypsum (1-9), Naphthalene-Peat-moss (1-9), and Naphthalene-Superphosphate (1-9). The liquids were applied at the rate of 88 pounds per acre and the dusts at the rate of 440 pounds per acre. On Pinto beans, Naphthalene-Sulfur (1-3.5) applied in drills at the rate of 400 pounds per acre, retarded the germination of the seeds, but in ten days the seedlings showed no ill effect from this application.

T. B. Randolph.

Acid Sulfur Composts: Mixtures made of equal parts by weight of barnyard manure and sulfur flour in January 1939, in five months developed a total acid content of about 4 per cent (based upon field weight) with a pH of about 1.0. Mixtures of sulfur and charred dehydrated citrus peel waste from the Citrus Exchange Dehydration Plant gave similar readings. After about 8 months the latter mixtures reached as high as $5\frac{1}{4}$ per cent acid and a pH reading observed that a heavy rain on the compost pit would leach out some of the free acid, but that due to the continued biological activity, in the mixture, the acidity would quickly build up again. In a laboratory test, a compost with a pH of 1.39 was subjected to repeated leaching till

it gave a reading of pH 3.53, after which it was permitted to stand at room temperature for six weeks when it read pH 0.68.

G. H. Godfrey and Herbert Rich.

Comparisons between Sulfur and Sulfur-compost in Rate of Acid Development in Soils: Mixtures of pH 8.08 soil and sulfur were made at rates of 0 gm. sulfur to 8.75 gms. soil, and whole number multiples thereof from 2 to 10. These rates corresponded from 1 to 10 tons per acre-foot of $3\frac{1}{2}$ million pounds of soil. If applied in a band 2 inches deep and 9 inches wide on potato rows spaced 3 feet apart, the actual rate of application of sulfur for the basic mixture would be only $83\frac{1}{2}$ pounds per acre. At twice the basic rate the figure would be $166\frac{2}{3}$ pounds per acre; at three times, 250 pounds per acre; at six times, 500 pounds per acre, etc. Similar mixtures were made of acid sulfur-compost and soil at corresponding rates as of sulfur content. All mixtures were moistened slightly and uniformly and placed in 2-quart glass jars. The jars were allowed to incubate at room temperature, and pH readings were taken on each jar at frequent intervals.

With the sulfur-compost soil at five times the basic rate (or 416 $\frac{2}{3}$ pounds sulfur per acre as applied to potatoes), the pH had dropped to 5.75 in only 30 days after mixing. With the straight sulfur mixture at double that rate, it dropped to pH 6.83 in the 30 days and to only 6.51 in 78 days. Thus there would appear to be a distinct advantage in favor of the sulfur compost for developing a desired acid condition in the soil in the location where it is desired within a reasonable time after application. With the sulfur-compost mixtures applied at lower rates, the desired pH was attained after longer periods of time; and at higher rates, in shorter periods. Information from this and other similar experiments has been applied in several disease control experiments in which increased acidity in limited zones of soil is desired.

G. H. Godfrey and Herbert Rich.

Effects of Various Acidifying Chemicals and Fertilizers on Soil pH: With a view to measuring the acidifying effects of "spot" applications of concentrated mixtures of soil with various acidifying materials, a jar experiment was conducted in September 1939. The initial pH of the soil was 7.11. The mixtures were made in the proportion of 1 part of chemical to 3 parts of soil.

Aluminum sulfate reduced the pH immediately (4 days reading) to 2.79, and it remained nearly the same continuously, with a pH of 2.70 at 32 days. Sulfur reduced the pH to 5.18 in 4 days and to 2.01 in 32 days. Sulfur compost (highly acid at the time of mixing) reduced it to 1.83 in 4 days and 1.10 in 32 days. The gypsum mixture read pH 5.99 at 4 days and 6.08 at 32 days. Sulfate of ammonia read 6.38 at 4 days and 5.68 at 32 days.

G. H. Godfrey and Herbert Rich.

Diffusion of Acidity Outward from Spot and Trench Applications of Sulfur: In one case, sulfur had been applied in a trench around a citrus

tree in a Victoria sandy clay loam (somewhat firm in texture and not readily permeable by water) in August 1936. In October 1939, a ditch was dug and the line of the original application cross-sectioned. Soil samples were taken at different points with relation to the still visible line of sulfur. There was a definite lowering of the soil pH from the normal of about 8.35 at the surface to 7.00 and 6.89 in soils in contact with the sulfur. Below the visible sulfur, there was a gradual and consistent increase in pH to about 8.00 at 6 inches below.

In another locality in sandy soil containing considerable shell, to which sulfur had been applied in spot applications in January 1938, with a normal pH of from 8.00 to 8.25, the pH was 2.08 in direct contact with the sulfur, 5.88 at 3 inches below, 7.32 at 6 inches below, and 7.09 at 9 inches below. At 3, 6, and 9 inches to one side of the sulfur there was little evidence of diffusion sufficient to bring about a permanent change in soil pH. In this and other similar soils in which tests were made, irregularly distributed pockets of semi-decomposed shell could very well account for inconsistencies in readings because of their last neutralizing effects on any developed acidity.

In an orchard with distinctly sandy and readily permeable soil lacking in shell deposits, with a pH around 7.0, diffusion studies showed a striking effect from the 1936 applications of sulfur. The pH reading was 3.42 at a point 2 inches directly above the line of sulfur. It dropped to 1.52 in direct contact with the sulfur, and then rose gradually (as manifest by readings at 1-inch intervals) through 2.38 at 3 to 4 inches, 3.40 at 7 to 8 inches, 3.69 at 11 to 12 inches and 4.29 at 13 to 14 inches; it then rose abruptly to 6.32 at 14 to 15 inches, and to 6.58 at 17 to 18 inches. There was likewise a marked lateral diffusion of acidity, with a reading of pH 3.72 at 5 inches to one side of the visible sulfur. Thus in this soil, which lacked the abundance of shell evident in others, there was a marked reduction in soil pH in a considerable volume of soil surrounding the region of application.

G. H. Godfrey and Herbert Rich.

SUBSTATION NO. 16, IOWA PARK

Texas Substation No. 16 is located in the Wichita Irrigated Valley, 2½ miles southeast of Iowa Park, and 10 miles west of Wichita Falls, in Wichita County, Texas. The latitude is 33 degrees and 55 minutes north; longitude 98 degrees and 39 minutes west; elevation 974 feet above sea level.

The average annual rainfall at this Substation is 30.15 inches for the 14-year period, 1926 to 1939, inclusive.

The Station comprises approximately 161 acres, of which 90 acres are devoted to crops under irrigation and 71 acres are in river bottom and creek bottom pastures and waste lands. The soil types on the Station are of the Miller and Yahola series and are fairly typical of the soils in the irrigated Wichita Valley. The Station was established in the fall of 1924

for the purpose of conducting agricultural research and experimental work with all crops grown in the Wichita Valley Irrigation Project. Irrigation water is furnished the station from Lake Kemp and Lake Diversion, through canals of the Wichita County Water Improvement District No. 2. A free and perpetual water right was given the Station by the Irrigation District at the time the Station was established. The work at this Station is directly concerned with the general improvement of agricultural crops and farming conditions in the Valley, and particularly stresses such phases of the work as vegetable growing, fruit production, alfalfa, cotton, small grains, and grain sorghum production, crop rotations, the study of the proper uses and amounts of irrigation water, and studies of root rot diseases of cotton and alfalfa. Studies are also made of other plant diseases as well as insects and their control. Breeding and feeding of sheep is also being given attention.

Cotton

Variety Test: Of 24 varieties of cotton included in the test this year the following five made over 600 pounds of lint per acre: D. P. L. 11A, 689 pounds; Stoneville 5A, 675 pounds; Hi-Bred, 629 pounds; Delfos 531B, 617 pounds; and Bryant Mebane, 615 pounds. Rogers Acala, Watson, Jennings, Ferguson 406, Mebane 141, and Cliett ranged between 500 and 600 pounds, in descending order named. Mebane, A. D. Mebane Est., Qualla, Kasch, Wilds Semi-Wilt Resistant Strain 2, Bagley, and Shafter Acala, ranged between 450 and 500 pounds in descending order. New Boykin, Hurley Special, Sunshine 116, Lone Star, Acala N-28-5, Mebane, A. D. Mebane Cot. S. Co., and Texas Special, ranged between 400 and 450 pounds of lint per acre in descending order, with Texas Special making the lowest yield of only 408 pounds per acre.

In earliness Hi-Bred ranked first with 64 per cent of the crop picked in 121 days from planting. Stoneville 5A was second with 53 per cent picked in 121 days, and Shafter Acala and Delfos 531B were third with 46 per cent picked in 121 days from planting. Mebane, A. D. Mebane Cot. S. Co., was latest in maturing with only 15 per cent picked in 121 days from planting followed by Mebane, A. D. Mebane Est., and Texas Special with 19 per cent and 20 per cent respectively in 121 days.

The body and uniformity were good in all varieties, while staple length ranged from $\frac{7}{8}$ inch for New Boykin to $1\frac{3}{16}$ inches for Wilds Semi-Wilt Resistant Strain 2.

In comparable yields for the ten varieties that have been included in the test for five years or more Mebane 141 ranks first with an average of 452 pounds per acre followed by Ferguson 406 with 442 pounds per acre. Other good averages were Watson with 428 pounds, Hurley Special with 424 pounds, Stoneville 5A with 419 pounds and New Boykin with 412 pounds. The lowest of this ten is Ed Kasch with 370 pounds of lint per acre.

Spacing Cotton: Mebane 141 was the variety used in this test and the spacings were 3, 6, 9, 12, 18, 24, 30, 36, and 42 inches. The 3-inch spacing

was far ahead in yield this year with 583 pounds of lint per acre followed by 487, 484, and 480 for the 6-, 12-, and 18-inch spacings respectively. The lowest yield of all was 274 pounds for the 42-inch spacing.

For the 8-year period 1932 to 1939, yields for the five closer spacings ranged from 416 pounds to 389 pounds per acre and are in inverse proportion to the spacings. All wider spacings average lower in yields.

Dates of Planting: This test has been conducted for a period of nine years. Mebane 141 is the variety used and plantings have been made at intervals of 15 days or as nearly so as possible from April 20 to July 15.

The third date of planting, May 22, made the highest yields this year, but for the 9-year period, 1931-1939, inclusive, to the earliest date of planting has the highest average yield. The second date of planting ranked second in yields this year while the fourth date of planting averages second highest for the 9-year period. It is apparent that a normal crop may be produced from plantings made between April 18 and June 1, with variations due to weather and seed bed conditions. Plantings later than June 1 make consistently lower yields. July 15 plantings do not mature any crop.

Amount of Irrigation Water for Cotton: The object of this test is to determine the optimum amount of water required to produce a normal crop of cotton. Both rainfall and supplemental irrigation water are considered from the time of pre-planting irrigation to the beginning of the harvest period. Mebane 141 is the variety used in this test. The season was unusually dry this year. A pre-irrigation was necessary for planting moisture and three subsequent irrigations were applied.

The yields this year were in direct proportion to the amount of water received ranging from 105 pounds of lint per acre on the dry land plat to 340 pounds on the plat receiving the heaviest irrigation treatment. This is also the order for the 8-year averages in which the yields range from 177 pounds on the dry land plats to 342 pounds on the plat receiving the most water.

Grain Sorghums

Variety Test: Due to the extremely unfavorable weather conditions yields of all early planted grain sorghums were rather low this season. Birds are becoming a serious pest and damage was severe in spite of all efforts to combat them.

Varieties that seem to have greater resistance to hot, dry weather conditions made the best records this year. Chiltex x Hegari ranked first with 30 bushels per acre. Club ranked second with 28 bushels per acre, and Chiltex ranked third with 26 bushels per acre. Hegari, a variety quite susceptible to extreme atmospheric conditions, made the lowest yield of only 7.7 bushels per acre.

In comparable yields over a period of years, Kalo ranks first with an average of 38.0 bushels per acre, Hegari x Chiltex F. C. 16171-1-2-4-3-3

ranks second with an average of 37.0 bushels per acre, and Club Kafir ranks third with 36.5 bushels per acre.

Variety and Spacing Test: Dwarf feterita, Hegari, and Texas Blackhul kafir are the three varieties used in this test. The spacings range from 3 to 24 inches. Severe weather conditions and bird damage held the yields down this year, particularly with Hegari and kafir.

In yields, feterita ranked first with 16.6 bushels per acre on the 24-inch spacing to 23.4 bushels per acre on the 6-inch spacing. Hegari, with at least a 30 per cent bird damage yielded from 10.3 bushels on the 24-inch spacing to 13.5 bushels on the 12-inch spacing. Kafir, with a 40 per cent bird damage, yielded from 4.4 bushels on the 24-inch spacing to 8.3 on the 6-inch spacing.

For the 9-year period 1931 to 1939, the closer spacings show the largest yields. The yields range from 34.4 bushels for Hegari in the 3-inch spacing to 19.3 bushels for kafir in the 24-inch spacing.

Amount of Irrigation Water for Grain Sorghums: The object of this experiment is to determine the proper amount of irrigation water and total water requirements for the production of a normal crop of grain sorghum in the Wichita Irrigated Valley. The total natural rainfall and the supplemental irrigation water are considered from time of pre-planting irrigation to crop maturity.

The season was unusually dry and a pre-irrigation was necessarily followed by two subsequent irrigations during the growing season. The amount of rainfall between the date of pre-irrigation to maturity was 10.23 inches. The pre-irrigation amounted to 4 inches on all except the dry land plats which receives rainfall only. The water for the other treatments ranged from 2 to 6 acre inches at each irrigation.

Yields ranged from 3.8 bushels per acre on the dry land plats to 33.6 bushels per acre on the plats receiving the most water—26.23 acre inches including rainfall. There was little variation in yields, however, from treatments of 22 inches or above. Under this amount yields declined rapidly.

For the 8-year period, 1932 to 1939, the dry land plats with an average of 14.83 inches of rainfall only, shows an average yield of 21.96 bushels per acre. Plats receiving irrigation water in addition to rainfall show increasing yields from 28.6 bushels per acre on plats receiving 23.2 acre inches of water to 41.6 bushels per acre on plats receiving 35.2 acre inches of water.

Hegari Strains: Five strains of Hegari were planted on three different dates, April 15, June 7, and July 17, which were as near the designated planting dates of April 15, June 1, and July 15 as planting conditions would allow.

The length of time from planting date to maturity decreased with each delayed planting in all varieties. The second date of planting had far more leaves per plant than either of the other dates, while there was little more than one leaf difference between the first and last plantings.

The number of stalks per plant and leaves per plant showed little variation for the different dates of planting. Plant height was 15 to 20 inches greater in the second date than in the first date, but was only 8 to 12 inches greater in the last planting than in the first planting.

Yields of grain were higher for all varieties in the second planting than in either of the other two, and were slightly higher in the last planting than in the first planting.

Double Cropping with Early Grain Sorghums: Quadroon and Sooner milo were the varieties used in this test and April 15 and June 15 were the planting dates.

Quadroon had more leaves and taller stalks than Sooner milo. Both varieties were about 10 inches taller in the last planting than in the first planting.

Quadroon made a third greater yield than Sooner milo in the first planting and more than twice as much in the later planting. Quadroon made a second crop of heads in the first planting but there was insufficient time to mature a second crop from the later planting. Sooner milo failed to make a sucker crop from either planting. Quadroon produced about 40 per cent more in the main crop from the late planting than from the combined main and sucker crops of the early planting.

Small Grains

Wheat Variety Test: Wheat yields were unusually good this year due to the fact that the test was located on land which had been in alfalfa for two seasons. Yields ranged from 42.2 bushels per acre for Oro x Tenmarq to 33.6 bushels per acre for Early Blackhull. The other varieties included this year were Tenmarq, Chiefkan, and Clarks Blackhull with yields of 38.5, 35.4, and 34.7 bushels respectively.

Oat Varieties: The unusually good oat yields in this test following 2-year alfalfa attest the value of alfalfa in the crop rotation program. Ferguson 922 made the highest yield of 117.8 bushels per acre followed by Texas Red Rust Proof with 114.4 bushels per acre. New Nortex was third with 112.6 bushels per acre, and Fulghum x Victoria was fourth with 101.3 bushels per acre. Frazier made the lowest yield of 88.9 bushels per acre. For a 3-year period, 1937 to 1939, New Nortex ranks first with an average of 65.9 bushels per acre, Texas Red Rust Proof ranks second with 65.1 bushels per acre, and Frazier ranks third with 51.4 bushels per acre.

Barley Varieties: Of five varieties of barley included in the test this year Wintex made the highest yield of 48.2 bushels per acre followed by

Tennessee Winter with 44.1 bushels and Finley with 43.2 bushels per acre. Harlan Hybrid 1-33-7 yielded 38.6 bushels and Harlan Hybrid 1-33-179 made low with 34.8 bushels per acre.

Crop Rotation Studies

This project consists of studies with eleven combinations of rotations comprising continuous cropping, two-year rotations, three-year rotations, and four-year rotations involving field crops of cotton, small grain, grain sorghums, and alfalfa.

For the current season, cotton on the continuous cropping series made the highest yield of 789 pounds of lint per acre, while cotton in a four-year rotation of cotton, grain sorghum, and 2-year alfalfa was second with 696 pounds of lint per acre, and cotton in a 3-year rotation of cotton, oats and alfalfa was third with 662 pounds of lint per acre. The continuous cropping cotton has the highest average over the 8-year period since the test was begun.

Grain sorghum in a 4-year rotation of cotton, grain sorghums and 2-year alfalfa ranked first with 48.0 bushels threshed grain per acre, and in a 2-year rotation of grain sorghum and cotton was second with 38.6 bushels per acre. A 3-year rotation of grain sorghum, cotton and oats was third with 35.4 bushels per acre. The continuous cropping grain sorghum made the lowest yield of 31.0 bushels per acre. The same order is held by these rotations over the 8-year period.

The highest yield of oats was 59.2 bushels per acre on a 3-year rotation of cotton, oats, and alfalfa which also has the highest rating for the 8-year period. Continuous oats was second with 30.2 bushels per acre and a 3-year rotation of cotton, grain sorghum and oats was low with 29.0 bushels per acre. These treatments hold the same rank over the 8-year period.

Alfalfa yields were low with 1.8 tons on the 4-year rotation of cotton, grain sorghum and 2-year alfalfa, 1.6 tons on continuous alfalfa and 1.3 tons on a 3-year rotation of cotton, oats, and alfalfa. The rank for the 8-year period is continuous alfalfa, 2.9 tons; a 4-year rotation of cotton, grain sorghum, and 2-year alfalfa, 2.9 tons; and a 3-year rotation of cotton, oats, and alfalfa, 2.0 tons.

Castor Bean Variety Test

Eight varieties of Castor beans were grown this year with yields of threshed grain per acre as follows: Conner, 1,277 pounds; U. S. D. A. No. 7, 1,248 pounds; U. S. D. A. No. 4, 1,129 pounds; Flowering, 1,109 pounds; Kolp, 1,064 pounds; Wagner, 971 pounds; Brazilian, 166 pounds; and Common, 85 pounds.

L. E. Brooks.

Lamb Feeding Experiment

Feeds can be grown abundantly in the Wichita Valley and the feeding of livestock has interesting possibilities. An experiment designed to demon-

strate the utility of local grown feeds, to make comparison between various feeds, and to determine the possibilities of marketing feeds on the hoof, was completed in January 1939. The experiment involved 120 head of Rambouillet lambs divided into 4 lots. Lot 1 was fed ground Quadroon heads, cottonseed meal and alfalfa hay; Lot 2 was fed chopped heads, cottonseed cake and alfalfa hay; Lot 3 was fed ground heads, cottonseed meal and Sudan hay with limestone supplement, and Lot 4 was fed chopped heads, cottonseed cake and Sudan hay with a limestone supplement. The length of the feeding period was 97 days.

In summarizing results, it may be said that any of the four rations proved satisfactory in finishing lambs for market. Alfalfa hay showed some advantages over Sudan hay even when the latter was supplemented with limestone. There was apparently a slight advantage in grinding the grain sorghum heads when fed with Sudan but not when fed with choice quality alfalfa hay.

A similar experiment with lambs somewhat larger in size was begun in October 1939 and will be concluded in January 1940.

J. M. Jones, J. H. Jones, and L. E. Brooks.

Fruit Adaptability Studies

Peaches: Weather conditions this year were suitable for the setting and development of a good crop of fruit on all varieties. A light frost April 7 reduced the number of fruit per tree to about what the trees should carry and the remaining peaches developed normally. Of the 32 varieties of peaches at fruiting age in the orchards in 1939 nearly all bore some fruit. Several late varieties were not able to mature crops however. Dr. Burton, Carman, and Belle have the best production records of all of the peaches which have been on trial at this station. All of these are white varieties of doubtful commercial value. The best yellow peaches are J. H. Hale, Leona and Elberta. Of these J. H. Hale has the best all around record. In the new orchards, which fruited for the first time this year, several varieties show some promise. The most outstanding varieties are Frank and Halehaven.

Plums: All varieties of plums set a good crop of fruit this year but few matured satisfactory crops. Sapa and Opata in the old orchard died of root rot just as they were ready to harvest. Yellow Iowa produced by far the largest crop, with Gold, America, and Munson following in that order. All of these varieties are seedlings, or crosses of native species. A comparison over a period of years shows Opata, America and Munson to be the best adapted varieties to the region from the standpoint of yields while America, Gold, Munson and Yellow Iowa appear best adapted from the standpoint of adaptability to soil and climate.

Apricots: Several varieties of apricots fruited this year. These trees all bloomed early and apparently the fruit was sufficiently advanced that

the frost of April 7 did little damage. The varieties making the best crops were Moorpark, Wilson's Delicious, and Stella.

Nectarines: Nectarines did not do so well this year. All fruit was small and of poor quality. Flaming Gold produced the best crop.

Grapes: The first condition necessary for success with grapes is resistance to root rot. There are some indications that a degree of success has been attained in meeting this condition. Champanel has so far survived contact with root rot for a period of 10 years. Several other varieties show some degree of resistance to the disease. The only variety producing more than a trace of fruit this year was Flame Tokay which developed without color.

Blackberries and Dewberries: On the station Austin dewberry and Dallas blackberry have been most productive. The Youngberry is a regular but shy bearer.

Strawberries: The only strawberry variety which has been grown on the station with any success is Mastodon.

Vegetables

Adaptability Studies: The vegetable variety trials included 67 varieties and strains representing 15 kinds of vegetables.

Beans and Peas: Of the six varieties of beans planted this year only the limas, Henderson Bush and Fordhook produced crops. String beans failed to make enough fruit to harvest. Neither of the two limas was superior to the other.

There were four English pea varieties on trial. Only Gradus was at all satisfactory. In addition to making the greatest yield Gradus showed the highest resistance to pea mildew.

Leaf Crops: There were four varieties of mustard, two of spinach, and four strains of Swiss chard in the trials. One variety of spinach, Summer Savoy, proved quite long standing. All chard varieties and strains were well adapted to the season. None of the mustard varieties were satisfactory as crops. As fall crops all chard and mustard varieties proved well adapted.

Root Crops: Included in this section are four varieties of beets, four varieties of carrots, four of turnips, six varieties of onions, and seven varieties of radishes.

Of the four varieties of beets on trial Detroit Dark Red was the outstanding variety. Red Chief, while outyielding Detroit was of lower quality. None of the four varieties of carrots were satisfactory, but the best was Chantenay. A severe infestation of Lygus bugs damaged the turnips to such an extent that no crop was harvested. None of the onions this year

matured satisfactory crops from seed. Red Weatherfield produced a good crop of usable bulbs from sets. As fall crops all varieties of turnips and beets produced excellent crops of good quality except that the roots were somewhat rough. Carrots failed to come to stand even though mulched with straw to shade the ground. There was difficulty in getting good stand of onions because of hot weather at planting time. Radishes as a fall crop was quite satisfactory, more particularly the winter varieties White Celestial and Black Spanish.

Cucurbits: Seven varieties of squash, three of pumpkin, six of cantaloupe, and six of cucumber were placed on trial this year. No squash varieties produced satisfactory crops because of squash bugs. The summer squash produced a few pounds of usable fruit, but the winter varieties were a failure. Pumpkins were destroyed by the same insect. The most satisfactory variety of cantaloupe was Superfecto. Although not the highest producing variety it was the most salable and produced the largest number of high quality melons. Mildew Resistant No. 45 was next and 936 third. The cucumber variety trials, while severely damaged by squash bugs, produced some fruit. Early Fortune and Earliest of All made the best yields, but Straight 8 produced the best quality fruit.

Salad Crops: Only one type of salad crop, leaf lettuce, was grown this year. Of these the best was Grand Rapids.

Production Trials

Sugar Beet Seed Production Trials: Date of planting and date of harvest trials were made this year. There was no difference in production between beets planted August 20, August 30 and September 10. Harvesting was done June 14, June 21 and July 8. The second date of harvest was twice as good as the first and 1.5 times as good as the third. The average production for all plats was 1,058 pounds of seed per acre.

Strawberry Soil Treatment Tests: Begun in 1936 these treatments have now completed their third year. Treatments were in duplicate as follows: 40 tons of manure per acre; 20 tons of manure plus 1 ton of lime; 2 tons of lime per acre; 1,000 pounds of sulfur per acre, 600 pounds of sulfur per acre and no treatment. After two fruiting years the plats receiving 20 tons of manure per acre and 1 ton of lime have produced the highest average yield of 1,839 pounds as compared with 1,336 for the 40 tons of manure per acre treatment and 539 pounds for the check plats. Growth was best on the high manure treatment plats although the difference between these plats and those receiving 20 tons of manure and 1 ton of lime per acre was slight. Growth was poorest on the check plats.

Shade Trees and Ornamentals

The most dependable shade trees are natives of this section of the state. Among them are the pecan, hackberry, western soapberry, mesquite, cot-

tonwood and sycamore. A tree which may have possibilities in the irrigated valley *Ulmus crassifolia*, a native elm which is doing very well.

With the exception of the cottonwood all of the trees are slow growing. The Russian mulberry can be used to advantage because of its resistance to root rot. *Chilopsis linearis* the flowering Willow is both hardy and attractive.

Coniferous evergreens that have proved adaptable to local conditions are: Red cedar, Pfitzer's juniper, Arizona cypress, and many arborvitae. A number of broad leaved evergreens, such as the ligustrums, pyracanthas, jasmines, and nandinas are showing desirable qualities as specimen, group and foundation planting materials.

Three introductions from the Bureau of Plant Industry are showing possibilities as ornamental shrubs. Two of these *Elaeagnus sp.* and *Calli-carpa dichotoma* may find use either as foundation plantings with other tall growing coarse leaved plants, or in group or border plantings. *Colutea sp.* is a fine leaved, rather low growing somewhat evergreen shrub bearing bladder like seed pods of good ornamental value.

Annual flowers for gardens which are consistently good are delphinium, coreopsis, calliopsis, gaillardia, *Corydalis montana*, *Linheimera Texana*, vinca, balsam, Iceland and Shirley poppies, petunia, cosmos, portulaca and verbena. Biennial and perennial flowers well adapted are Dianthus, chrysanthemum, Christmas daisy, oriental poppy, day lilies and iris.

B. S. Pickett.

Root Rot Studies

Crude Oil Treatment on Cotton Land: This test included five rates of application of crude oil to land known to be severely infested with the root rot fungus. The test was arranged on a Latin square with six replications. The oil was natural crude from a well in the local Kamay oil field. Application of oil was made in January 1938 and no more has been applied. Emergence was good and all plats were thinned to uniform stands.

The treatments were (1) 705, (2) 1,410, (3) 4,231, (4) 7,052, and (5) 9,873 gallons of oil per acre and, (6) no-treatment check.

A final check at the end of the growing season revealed the following percentages of dead plants due to root rot: Treatment (1) 28 per cent, treatment (2) 41, treatment (3) 36, treatment (4) 23, treatment (5) 24, and treatment (6) 25 per cent. These percentages are lower in all plats than for the preceding year but, again there seems to be no correlation between the oil application and death losses.

The average yields of lint per acre for the various treatments were: treatment (1) 349 pounds, treatment (2) 414, treatment (3) 417, treatment (4) 411, treatment (5) 457, and treatment (6) 415 pounds.

Grape Resistance Studies: Various grape root stocks which have shown marked resistance to root rot in other localities have been tested over a period of years beginning in 1934. Included in these trials were: Champanel, Lomanto, Lufkata, Black Spanish, Dogridge, La Pryor, Mustang, Cleota, Candicans, Ladono, *Vitis champani* *V. cinera*, and *V. rupestris*. Results thus far have shown that these stocks are not entirely immune from root rot, but that most of them are decidedly more tolerant of the disease than the grape stocks commonly used.

Sorghum as a Root Rot Remover: A field on which root rot tests have been conducted for a number of years and which was known to be severely infested with the root rot fungus (*Phymatotrichum omnivorum*) has been planted to Red Top cane for six consecutive years, and will continue to be planted in grass crops for a number of years to determine whether the fungus can be killed out by continuous cropping with a nonsusceptible grass crop. The length of time this test will be continued will be determined by the viability of the sclerotial stage of the fungus. Sclerotia have been reported viable after a number of years in storage at College Station.

L. E. Brooks.

SUBSTATION 19, WINTER HAVEN

Substation 19 is located in Dimmit County, between Carrizo Springs and Crystal City, in the center of a large area specializing in the production of vegetables with irrigation. The substation is located on fine sandy loam (mostly Webb and Crystal series) with about 100 acres in cultivation. Irrigation water is supplied by pumping from underground sources.

The average rainfall for 9 years is 20.62 inches, with a total for 1939 of 23.27 inches. The months of January to May were very dry and most of the rain fell in the latter half of the year. Good crops of sorghum were secured without irrigation. No killing frost occurred in the fall until December 29, and an excellent season for tomatoes, peppers and other fall crops occurred. Abnormally high temperatures on March 26, 27 and 28 caused damage to flowers and young shoots in orchard and vineyard crops. Thrips damaged onions considerably and the strawberry crop was below normal. Good crops of tomatoes, citrus and dates were obtained.

The program consists of variety and cultural studies of vegetables, fruits and other irrigated crops and also includes breeding projects on onions, cantaloupes, spinach, strawberries and tomatoes. Disease and insect control are important studies. Insect work is under the Division of Entomology.

Fruits

Adaptability: Varieties with either flowers or new growth on March 26, 27, or 28 had yields considerably reduced because of high temperatures and low humidity.

Apples set a good crop, although trees are only 6 years old. All varieties bore fruit. Helm and San Jacinto were of good quality.

Apricots set a light crop and only Toyahvale and Tilton set an appreciable crop.

Avocados were of the best quality since they were planted. Ganter and Mexicola ripened fruits in August.

Only a light crop of guavas was produced although there was no frost injury in the winter. Feijoas had a good set on Coolidge and none on Choicena, but the fruits failed to ripen normally.

Jujubes bore two crops of fruit, the second being of very high sugar content. Chinese Mulberry as usual had a heavy crop of richly flavored fruit.

Most peach varieties failed to bear but reasonably good crops were secured from the following: Luken's Babcock, Pallas, Saucer (Peento), Smith, Luttichau, Waldo and Frank. Root-rot and sun-scald on the trunks have seriously affected many of them. Heading the trees low would seem to be desirable.

All pear varieties bore this year. Pineapple, LeConte and Douglas had the heaviest crops. Best quality for eating were secured from Wilder's Early and Bartlett.

Persimmons were harvested while firm and ripened successfully off the tree. Hachiya and Tamopan had good crops of good flavored fruit.

Plums bore a good crop with best yields from Munson, Excelsior, Gonzales and Burbank.

Quince bore a light crop.

Citrus Varieties: Yields of Satsuma varieties have gradually increased each year. Owari trees eight years old bore excellent crops of fruit with a number of trees yielding 500 pounds or more.

On seven-year-old trees good yields were obtained from Foley, Owari, Horie, Kawano, Silverhill and Miyasaki satsumas. Silverhill is a promising variety for the December market because of smooth fruits and low "rag." Owari was the best variety for the November market.

Best yields of orange varieties were obtained from Joppa and Louisiana Sweet. The Texas Navel variety had a light yield on all stocks.

All grapefruit and kumquat varieties, Meyer lemon and Lakeland limequat had good yields of commercial fruit.

Several tangelo trees bore this year. Webber is especially promising because of early ripening. This year the fruits were ripe on September 10 but were beginning to dry out by December 1. Other unnamed tangelo selections have considerable promise because of unusual flavors.

Clementine tangerine bore a comparatively light crop and fruit was drying badly by December 15.

Citrus Rootstocks: Seed yields were estimated on 27 varieties in 1939. Counts were made on the average number of seeds per fruit and per pound of fruit. Heavy yields of seed may be expected from Carrizo citrange, *Poncirus trifoliata*, Duncan grapefruit, Kansu orange, Changsha orange, Swatow tangerine, and citrumelo. Further tests are planned with these varieties.

1932 Buds have yielded three crops in most cases and the following trends are showing up: Ikiriki Satsuma is making better growth and yields on Savage citrange than on trifoliata. Kawano is yielding better and has made better growth on 15137 citrange than on several others. No significant differences are apparent in yield or growth of Owari on various stocks. Growth of Silverhill has been slightly better on Morton citrange but differences are small so far.

1934 Buds have yielded small fruit crops for two years. So far differences in growth and fruiting on various stocks are small.

Orange varieties budded on various citrange stocks and *trifoliata* in 1933 have borne two good crops and some differences are becoming apparent. Hamlin has grown larger on 15137 citrange but fruit yields are the same on all stocks. Joppa is greatly dwarfed on *trifoliata* and yields are greatly reduced. Joppa yields are about the same on citrangequat and Rusk citrange although the trees on Rusk are considerably larger. Differences in Texas Navel are insignificant between various stocks.

Date Varieties: Good crops were matured on most varieties in spite of rainy periods. The most outstanding varieties this season were seedlings, S-11, S-13, N-14 and S-15. All four were of good dessert quality. S-15 is seedless and ripened during November and December. Considerable trouble was experienced with wasps this year. It was difficult to bag the bunches carefully enough to keep out the wasps.

Grape Varieties: Yields of a number of varieties were greatly reduced by 102° F. at the time of flowering. Some of the better yielding varieties this year were: Black Malvoise, Black Muscat, Chasselas Fontainebleau, Grenache, Bastardo, Black Spanish, and Carignane. A total of 143 named varieties are being tested.

Grape Rootstocks: The grafting test was very disappointing and resulted in almost total failure. It is probable that the high temperatures in March scorched the newly emerging shoots. No. 3309 was found very susceptible to nematode. It seems that LaPryor and *candicans* selections are resistant.

Strawberry Varieties and Breeding: Varieties began fruiting in December. The most productive varieties until March 1, were Excelsior, T6, Mis-

sionary, T29, T30 and T28. The most productive for the whole season were Missionary, Excelsior, T24, T10, T50.

In four years of records the best yields from desirable commercial varieties were in order: Alamo, T34, T19, Ranger, T56, T28 and Riogrande.

Notes were taken on 3,311 seedlings from 1938 crosses, all having Ranger as the pollen parent. A total of 373 selections from these seedlings were transplanted in the fall of 1939 for further testing. There were a number of outstanding selections for flavor and earliness, especially in the T10 x Ranger cross.

E. Mortensen.

Ornamentals

Some of the more outstanding ornamentals grown two or more years are: *Eucalyptus crucis*, *Bambusa ventricosa*, *Baekia platycephala*, *Xylosma senticosum*, *Duranta repense*, *Tamarix chinensis*, *Cordia boissieri*, *Dalea formosana*, *Tecoma stans*, and *Grevillea robusta*.

Field Crops

Corn Varieties: Pioneer 307 had the best yield in 1939, followed by Yellow Surcropper, Mexican June, Denco Yellow Dent and Reese Drouth Resister. In a period of years, excluding varieties grown only one year, the best five varieties have been: Yellow Surcropper, 20.9 bushels; Reese Drouth Resister, 20.4 bushels; Red June, 19.8 bushels; Golden June, 19.8 bushels; Mexican June, 19.4 bushels; and Surcropper 19.4 bushels per acre.

Flax Varieties: A fairly comprehensive planting of varieties was ruined by a heavy infestation of bugs in the spring (*Holochroa*). Some seed of Giza was obtained in boll-set after May 1.

Sorghum: A test of Quadroon and Sooner milo for various harvesting methods was made. Quadroon made the best crop.

E. Mortensen.

Vegetables

Variety Description (In cooperation with the Bureau of Plant Industry, U. S. Department of Agriculture): The object of this work has been to obtain definite descriptions of ideal types of the more widely used vegetable varieties. In the fall of 1939 the third crop of peppers and eggplants was grown, the first having been grown in 1937, the second in 1938. In the pepper trial there were 34 strains representing 10 sweet varieties and 7 hot ones. In the eggplant test there were 10 strains representing six varieties. Considerable emphasis was given to detailed descriptions. In spite of a season somewhat more favorable than those of 1937 and 1938, it was again evident that eggplants are more adapted to August and September weather than are peppers. All varieties of the former grew and produced well. Some varieties of the latter especially some of the sweet ones such as California Wonder, Early Giant and

Ruby King often produce small misshapen off-type fruit in the early season while the temperature is still high and the relative humidity low. The pungent varieties are less affected by these conditions than are the mild ones.

Adaptability Studies: During the year, the following numbers of varieties and strains of vegetables were included in the trials: cantaloupes 26, Sweet corn 5, tomatoes 32. Many of the tomato varieties were tested both in the spring and the fall.

Few if any varieties of cantaloupes were found to exceed New Seed Breeders (a strain of Hale's Best), and Mildew Resistant 45 in general adaptability and usefulness. Among the newer sorts, Globe of Gold was attractive, productive and high in quality.

The Iogold strains of Sweet corn P.39.I.45 & P.51.I.45 again showed considerable resistance to ear worm damage and thus justified favorable reports in the past. Among tomato varieties for shipping Stokesdale proved to be outstanding in the important fall crop. The good yields and fine appearance of this variety for the past several seasons in station trials would warrant a greater interest in it on the part of commercial growers. Marglobe, Pritchard, and even the now rather popular Rutgers did not produce nearly as much marketable fruit as Stokesdale. However, Bonny Best, Clark's Early and Chalk's Jewel, three varieties all related in type, produced still more than Stokesdale.

Onion Fertilizer Tests at Outlying Locations: The tests which were initiated two years ago on a Laredo silt loam at Laredo, a Laredo very fine sandy loam at Eagle Pass, and a Monteola clay at Big Wells were repeated this year. On none of these soils has the application of potash been consistently profitable. In most cases a fertilizer with a 1-2-1 or a 1-2-0 ratio has caused the onions to produce just as well as those where one with a 1-3-1 or a 1-3-0 ratio has been used. Only on the Laredo very fine sand has nitrate of soda side dressings been profitable. A full and more detailed report is being prepared for a separate station publication.

Onion Seedbed Fertilizer Test: Fertilizing the onion seedbed would seem to be a profitable practice on the basis of an experiment initiated this year. Bermuda onions receiving 100 pounds per acre of 11-48-0 fertilizer in the seedbed yielded 300 bushels of onions per acre as compared with 236 bushels produced by similar onions unfertilized. Both lots of onions were fertilized alike in the field.

Comparison of Dry Sets with Green Plants: Through cooperation with Dr. J. P. McCollum of the Illinois Experiment Station some dry sets of the Yellow Bermuda onion were raised in the North, and then green sets or plants from the same lot of seed were grown at Winter Haven. The dry sets were planted at different times, the final yields of dry bulbs obtained in April were compared with yields obtained from the plants set out at the regular time for this section. Records were kept on the normal

and various cull bulbs produced, and comparisons made. On the basis of one year's work it is impossible to draw any very definite conclusions, but it can be stated that medium sized dry sets planted around the time of planting for the green sets gave results of some promise.

Spinach Irrigation: Spinach in plats receiving seven irrigations yielded 329 bushels per acre or 219 bushels per acre more than spinach left un-irrigated. This was for spinach planted January 18 on sandy loam soil, and harvested March 23. Spinach in intermediate treatments yielded more or less in proportion to the water it received. The only effective precipitation during this period was one of 0.48 inch in January when the spinach needed it the least. Those results are more or less in agreement with previous tests conducted in the spring, but contrary to tests conducted in the fall. In the latter season the less the irrigation the greater the yield—usually, but in the spring the reverse is evidently more likely to be true.

Frame Garden: A sub-irrigated frame garden used over four times as much water as a surface irrigated one in a test conducted during May and June. The soil used was Crystal fine sandy loam. The growth of turnips and radishes was much more satisfactory with surface irrigation than with sub-irrigation.

Breeding Vegetable Crops: Work is being continued in the improvement of Summerset, a heat resistant tomato which bears fruit in the Winter Garden Region during the months of July, August, and September when the temperature is high and the relative humidity usually low. Owing to the loss of a large seed crop due to an early freeze in 1938 considerable attention had to be given in 1939 to increasing the stock of seed. The variety has been crossed with Bison with hope of developing a still better variety, but it is too early as yet to report on the progress made by this step.

The onion breeding work was also continued, but progress is slow, chiefly because of the limited scale on which the work has to be done and also because it takes two years to go through a generation. Serious losses were suffered in the spring of 1939. Evidently the line of Yellow Bermuda which has been selected for freedom from defects has become more susceptible to pink root and thrips for all but a few plants were lost from these pests and as a result the seed harvest was cut drastically. The work looking toward thrips resistance is progressing slowly.

Leslie R. Hawthorn.

Dormancy-Breaking Test of Onions: In an attempt to find ways to speed up the onion breeding program, without resorting to the use of premature seeders which are undesirable commercially, mature bulbs (25 bulbs in each lot) were subjected soon after harvest in April to 29 different treatments involving common storage cold storage, wounding, the use of indole-acetic acid, and ethylene chlorohydrin. These treatments

were given alone as well as in various combinations with each other. Wounding alone, and wounding combined with cold storage were among the most effective treatments so far as the stimulation of growth was concerned, but no treatment resulted in the production of seed or even of an inflorescence by September, the time at which seed was needed for planting the new crop.

Leslie R. Hawthorn and S. S. Ivanoff.

Plant Diseases

Eggplant Yellows: This disease, locally known as "eggplant yellows" and resembling in symptoms the calico type of virus disease was transmitted to healthy plants of the variety Black Beauty by inoculation with extracted plant juice, both by rubbing or by puncturing. There were more than 10 inoculation trials made in the seedbed and in the field during various seasons in which approximately 1000 plants were employed. Infection resulting from inoculation varied from 0 to 12 per cent, with the control, uninoculated plants remaining healthy after the usual incubation period. The degree of infection apparently depended upon the condition of the plants, upon the dilution of the infectious juice and perhaps upon other factors not well understood. Ordinarily the disease was not transmitted or transmission was very low when the inoculated plants were stunted or were growing abnormally because of unfavorable environmental conditions. The highest infection by artificial inoculation was produced when the plants were young and growing vigorously. Natural infection is much more common during the fall growing season than during the early spring season.

The incubation period varied from 14 to 24 days, apparently depending upon season and temperature. In spring most of the infected plants had an incubation period of 18 to 21 days.

Infection was produced regardless of whether the inoculated plants were treated previously with sulphur or not. In one case young plants were dusted 4 times previously to inoculation and 2 or more times after inoculation. Eleven per cent of the inoculated plants became infected while the plants which were likewise dusted but not inoculated, remained healthy. Infection was also induced in plants in which, previous to inoculation, a few drops of a 2 per cent suspension of colloidal sulphur were injected. It seems that the presence of sulphur within the plant or as dust upon the plant does not significantly prevent artificial infection.

Extracted plant juice from diseased plants, slightly diluted with water, was passed through Seitz filter and then used to inoculate healthy plants but, in the few trials made, no positive case of infection occurred. Seed obtained from diseased plants produced only healthy plants.

Attempts to isolate a casual microorganism on common culture media, from diseased leaf, petiole, and stem tissue, under aseptic conditions,

have so far been unsuccessful. It appears that this disease is an infectious one and is caused by a virus.

Tomato Fruit Pox: Studies on the cause of tomato fruit pox have been continued. The fruit pox is an abnormal condition expressing itself by the appearance of small, dark green spots and short or long streaks upon the green tomato fruit which later may turn into pock-like marks and depressions. The seriously affected fruit is unmarketable. The disease was again prevalent on the spring and fall crop of 1939 throughout the Winter Garden region and was particularly destructive in Quemado Valley where whole fields were seriously affected and the average loss to the crop for that locality were estimated at above 10 per cent. Recent observations and tests have shown that this condition appears to be non-infectious and non-parasitic in nature and seems to be brought about by a combination of temperature, moisture and sunshine conditions. The work is being continued.

Breeding Cantaloupes for Resistance to Downy Mildew: Work on breeding cantaloupes of good eating and shipping qualities for resistance to downy mildew (*Peronoplasmodium cubensis*) and other diseases was started in 1938 and continued through 1939. Because of favorable soil and climate, a disease resistant commercial melon would be very valuable to growers in Southwest Texas. Thus far a number of disease resistant inbred lines have been obtained which have also shown some resistance to powdery mildew (*Erysiphe cichoracearum*) and to the melon aphid. Some of these lines were crossed with commercially desirable strains and experimental hybrids were obtained which showed some promise as to resistance, shipping and eating qualities. The work is being continued.

Control of Downy Mildew of Cantaloupes by Dusting: Tests on the control of downy mildew of cantaloupes (*Peronoplasmodium cubensis*) by dusting showed promise in the spring of 1939. The dust applied with a hand duster contained Grasselli copper compound A-11 per cent, common wheat flour 10 per cent, and talc 79 per cent. The plants were dusted seven times, beginning 7 weeks after planting and continuing at about weekly intervals, for the following seven weeks. The disease appeared in severe form by the time the fruit was beginning to ripen and destroyed most of the undusted vines while most of the dusted ones escaped serious injury. Of the 234 plants not dusted 74 per cent were destroyed or nearly destroyed by the disease while of the dusted plants only 2 per cent were lost. The dust did not injure the vines in spring but in a later trial made in late summer the dust injured the vines considerably. In the Winter Garden region where the climate is relatively dry it is possible that the number of dustings might be reduced by applying the dust only immediately after a rain or during heavy dew falls, but that remains to be tested. Because of the cost of dusting and the exacting manner of application, the control of downy mildew by fungicides has not been found practical.

Dusting for the Control of Downy Mildew of Spinach: Spinach of the varieties Bloomsdale Savoy and Viroflay was dusted with sulphur and copper fungicides (about five per cent of metallic copper in each), for the control of downy mildew (*Peronospora spinaciae*). The spinach was planted in rows and dusted 4 times, beginning when the plants were about 9 weeks old and continuing for about 5 weeks afterwards. The results showed that the dustings increased the yield in every case, the increase ranging from about 75 per cent to about 100 per cent over the undusted checks depending upon the fungicide. The dust fungicides used were: (1) Grasselli Copper Compound A flour—talc, in the proportion of 11:10:79; (2) Copper Sulphate (monohydrate)—lime (hydrated)—talc, in the proportion of 25:25:50; (3) Sulphur (mesh 325); (4) Cuprocide (red copper oxide)—flour—talc, in the proportion of 6:10:84; (5) DuPont 1N-1279-A-5 and talc, in the proportion of 20:80; (6) Tennessee Copper 34 and talc, 15:85; and (7) Tennessee Copper 149—flour—talc, in the proportion of 10:10:80. The best results so far were obtained with Grasselli Copper Compound—flour—talc mixture. Some injury to the plants resulted particularly in the case with sulphur, when the dust was applied during hot weather. During the cool weather in winter and early spring when most of the spinach is grown, the dust fungicides did not cause any injury. Bordeaux mixture (3:3:50) also used in the trials, injured the plants severely in hot weather. The trials on the control of downy mildew are being continued and have not reached the stage where the results could be recommended to the growers.

Simultaneously with the dusting experiments other trials were made in which the fungicides were introduced in the irrigation water. Control of downy mildew is also sought through development of disease resistant varieties.

Breeding Onions for Resistance to Pink Root: The work aiming to produce an onion of good commercial qualities adapted to the Winter Garden Region and at the same time to be resistant to the destructive pink root disease (*Phoma terrestris*) is being continued. About 50 selections made for resistance in the spring of 1938 have been carried through the first generation of inbreeding and the inbred seed has been planted in disease infested soil for further tests. Additional selections for resistance were made during the season of 1939 and have been included in the test.

S. S. Ivanoff.

Insects

Eggplant Yellows: Testing for insect transmission of this disease has been continued. More than 100 species of insects have been collected on eggplants. Eight of the insects which were suspected as more likely to carry the virus were caged on healthy plants without obtaining transmission of yellows.

In 1939 untreated plants had an average of 58 per cent yellows by the end of the season, whereas only 4 per cent had the disease in the

plats dusted with sulphur in the seedbed only. When sulphur applications were made in the seedbed and also two to four times after transplanting, complete control of the disease was obtained. Soil applications of sulphur at the rate of 500 pounds per acre reduced the yellows to 15 per cent. Dusting with hydrated lime in the seedbed and four times after transplanting also greatly reduced the amount of yellows, but this treatment resulted in lower yields.

S. E. Jones.

Tomato Fruitworm (*Heliothis armigera* Hbn.): In the fall of 1939, tests were conducted on 44 field plats. The treatments were replicated and the results statistically analyzed. It was found that calcium arsenate undiluted and cryolite-sulphur (1-1) dusts were equally effective against the fruitworm and that both gave significantly better control than calcium arsenate-sulphur (3-1).

Damage was lighter in 1939 than in any year since 1934. Results, however, were in line with those previously obtained. It appears that profitable control of the tomato fruitworm can be obtained by applying either calcium arsenate or the cryolite-sulphur (1-1) dust at weekly or 10-day intervals, beginning when the plants start fruiting in the fall and stopping before there is danger of a poisonous residue being on the fruit at harvest.

Beet Leafhopper on Spinach (*Eutettix tenellus* Baker): This insect was present in small numbers during the spring. An outbreak of curly top appeared during November, the first time severe damage has been noted since the winter of 1935-36. Some fields had 70 per cent diseased plants. The leafhopper and curly top were found in every spinach field examined in Southwest Texas. The range extended from Comanche, Brownwood, San Angelo, San Antonio, and Laredo west to Ft. Stockton, Alpine, and Presidio. Males were predominant during November, but had largely disappeared by the end of December. No nymphs were found.

S. E. Jones.

Onion Thrips (*Thrips tabaci* Lind.): Tests of materials for controlling this pest were conducted along two lines. A power sprayer was used to make six applications of proprietary materials to field plats at the rate of 125 gallons per acre at a pressure of 350 pounds. The differences in yields were not significant. In another method, evaluation of the materials was based upon actual counts of thrips on the onion plants before treatment, and two and four days after applications were made. This method provided information on the effect of the materials on both nymph and adult thrips and on the length of protection obtained by the insecticides used. The tests should be made before the thrips population becomes so abundant that it is difficult to make an accurate count. The first infestation record after application showed that there was a reduction of 50 per cent or more of the adults as a result of eight of the ten treatments. The nymphs were reduced 50 per cent or more by only

three of the treatments. Four days after application only one of the materials gave control of adults and nymphs. This was a diluted sticky, tree-banding material which must be tested further before practical application is possible.

There is considerable variation in the ability of different onion varieties to withstand thrips injury. The Grano variety produces a much higher yield than the Yellow Bermuda in the presence of a severe thrips infestation.

S. E. Jones and H. Menusan.

The Lesser Cornstalk Borer (*Elasmopalpus lignosellus* Zeller) was a pest of field peas, lima and snap beans during the warm months of the year. Damage was also noted on young peach seedlings in the Station nursery.

The Bean Leafhopper (*Empoasca fabae* Harris) was destructive to snap beans throughout the Winter Garden during September and October. Sulphur dust was an effective remedy whenever properly applied.

The Cabbage Webworm (*Hellula undalis* Fab.) ruined 25 per cent of the cauliflower plants in some fields during October. The diamond back moth (*Plutella maculipennis* Curtis) was the most destructive pest to cruciferous crops during the fall months. Satisfactory control of both insects was obtained by dusting with calcium arsenate when the plants were small and then using a rotenone-bearing dust.

So-called desert termites were active on lawns and range grass throughout Southwest Texas.

A stink bug (*Chlorochroa ligata* Say) was destructive during March to a small planting of flax grown on the Experiment Station. The seed crop was severely damaged, although other nearby fields of flax were less injured. Bluebonnets also were attacked and damaged.

S. E. Jones.

COOPERATION

Memoranda of agreement providing for cooperative research have been entered into or continued during the year with the following bureaus of the United States Department of Agriculture:

Bureau of Agricultural Economics:

1. A study of agricultural adjustment in Texas;
2. Cotton fiber and spinning research (also with the Bureau of Plant Industry and the Texas Engineering Experiment Station);
3. A study to determine the economic and social effects on farms resulting from the operation of a definitely planned program of soil conservation;
4. An estimate of the farm population and farm population movements;
5. The accuracy of small samples for wool shrinkage and grading determinations;

6. A study of Texas farm leasing arrangements in relation to the conservation of agricultural resources.

Bureau of Animal Industry:

1. Investigations of the loco problem in Western Texas;
2. Beef cattle husbandry investigations relating to the fattening of steers at different levels of feeding (also with Bureau of Plant Industry);
3. Beef cattle feeding investigations to determine the quantity of carotene required for growing and fattening steers;
4. Beef cattle feeding investigations relating to mineral-deficiency studies in range beef-cattle production;
5. A study of the inheritance of skin folds in Rambouillet sheep;
6. Improvement of sheep for western ranges through the application of breeding methods;
7. The mechanism of infection, resistance, and immunity in the contagious, infectious, and parasitic diseases of domestic animals and poultry.

Bureau of Agricultural Chemistry and Engineering:

1. Research on citrus products and on methods of preservation of fruits and vegetables;
2. Research on utilization of farm products (Southern Regional Laboratory, New Orleans).

Bureau of Biological Survey:

1. Regional and state wildlife research (also with the Texas Extension Service and the State Game, Fish, and Oyster Commission).

Bureau of Plant Industry:

1. The production, improvement, and diseases of ccreal crops, particularly corn, wheat, oats, sorghum, and rice;
2. The production, improvement, and diseases of cotton;
3. Field testing of Satsuma orange varieties and hybrids and stock plants for them;
4. Study and description of American varieties of vegetable crop plants for the purpose of establishing variety type standards;
5. Investigations in the development of forage and soil improving crops adapted to Northern Texas and contiguous areas (at Substation No. 12, Chillicothe);
6. Experiments in the testing of dates at Substation 15, Weslaco, and in Southwest Texas;
7. Investigations on insecticide and tannin plants and their possibilities as crops in the United States;
8. Vegetable breeding investigations in the Southeastern States and at the U. S. Regional Vegetable Breeding Laboratory;
9. Investigations on introduction, breeding, and testing varieties and seedlings of sweet potatoes;

10. Investigations on the occurrence of boron injury to citrus and other crop plants in the Lower Rio Grande Valley;
11. Soil surveys in Texas.

Bureau of Entomology and Plant Quarantine:

1. Investigations of insects and parasites affecting livestock;
2. Cotton insect investigations, including biology and control of pink bollworm and cotton bollworm;
3. Investigation on the resistance of honey bees to American foulbrood.

Soil Conservation Service:

1. Soil and water conservation research in the State of Texas, at Temple, Tyler, Spur, Amarillo, and Brushy Creek Watershed.

Bureau of Home Economics:

1. Study of body measurements for sizing children's garments and patterns.

LETTER OF TRANSMITTAL

September 15, 1939.

Director A. B. Conner,
Texas Agricultural Experiment Station.

Dear Director Conner:

There is submitted herewith the annual financial report of the Texas Agricultural Experiment Station for the fiscal year ended August 31, 1939.

In accordance with Subsection 1, Chapter 444, General and Special Laws Forty-fifth Legislature—Regular Session, all exhibits and schedules contained in this report have been prepared as nearly as practicable in conformity with the suggestions made by the National Committee on Standard Reports for Institutions of Higher Education.

Respectfully submitted,

M. P. HOLLEMAN, Chief Clerk.

Approved:

W. H. HOLZMANN,
Comptroller of Accounts.

EXHIBIT A

Texas Agricultural Experiment Station Balance Sheet
As at August 31, 1939

ASSETS

I.	CURRENT FUNDS			
A.	RESEARCH AND GENERAL			
	Cash.....	\$	116,506.50	
	Balance in State Appropriations (Schedule B-1a).....		7,136.73	
	Feed Control Tags			
	Inventory.....	\$	1,190.89	
	C. O. D. Shipments.....		656.09	1,846.98
	Supplies and Crops Inventories			
	Supplies.....		123,666.85	
	Crops.....		10,753.40	134,420.25
	Total Research and General.....			\$ 259,910.46
B.	AUXILIARY ENTERPRISES AND ACTIVITIES.....			None
C.	CURRENT RESTRICTED FUNDS			
	Cash.....	\$	7,351.94	
	Total Current Restricted Funds.....			7,351.94
	TOTAL CURRENT FUNDS ASSETS			\$ 267,262.40
II.	LOAN FUNDS.....			None
III.	ENDOWMENT FUNDS.....			None
IV.	PLANT FUNDS			
	A. UNEXPENDED.....			None
	B. INVESTED IN PLANT			
	Physical Plant (Exhibit E).....	\$1,266,939.37		
	Total Invested in Plant.....		\$1,266,939.37	
	TOTAL PLANT FUNDS ASSETS.....			\$1,266,939.37
V.	AGENCY FUNDS.....			None
	GRAND TOTAL ASSETS.....			<u>\$1,534,201.77</u>

EXHIBIT A

Texas Agricultural Experiment Station Balance Sheet
As at August 31, 1939

LIABILITIES

I. CURRENT FUNDS

A. RESEARCH AND GENERAL

Accounts Payable

Main College—Working Fund.....	\$	10,000.00	
Main College—Feed Control			
Tag Inventory and C. O. D's.....		1,846.98	\$ 11,846.98

Reserve for Supplies

and Crop Inventories.....			134,420.25
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Revolving Funds Balances (Sch. B-4).

10,075.03

Current Balances (Exh. B)

Appropriated for Special Purposes

Federal Hatch Fund Balance....	\$	1,476.18	
Federal Adams Fund Balance....		1,304.18	
Federal Purnell Fund Balance....		5,910.50	
Federal Bankhead-Jones Fund			
Balance.....		15,874.58	
State Apprns. Bals.—Main Station		598.17	
State Apprns. Bals.—Substations.		4,817.50	
Sales Funds Bals.—Main Station.		26,049.14	
Sales Funds Bals.—Substations...		45,816.89	

Total Appro. for Special Purposes...

101,847.14

Reserve for Contracts and Orders...

1,721.06

Total Research and General.....

\$ 259,910.46

B. AUXILIARY ENTERPRISES AND ACTIVITIES

None

C. CURRENT RESTRICTED FUNDS

Fund Balances

(Per Exhibit B and Schedule B-3)

7,351.94

Total Current Restricted Funds.....

7,351.94

TOTAL CURRENT FUNDS LIABILITIES.....

\$ 267,262.40

II. LOAN FUNDS.....

None

III. ENDOWMENT FUNDS.....

None

IV. PLANT FUNDS

A. UNEXPENDED.....

None

B. INVESTED IN PLANT (Exhibit E)

Net Investment in Plant..... \$1,266,939.37

Total Invested in Plant.....

\$1,266,939.37

TOTAL PLANT FUNDS LIABILITIES

\$1,266,939.37

V. AGENCY FUNDS.....

None

GRAND TOTAL LIABILITIES.....

\$1,534,201.77

EXHIBIT B

Summary Statement of Current Funds

For the Year Ended August 31, 1939

BALANCES, September 1, 1938

Current Funds—Research and General			
Reserve for Outstanding Orders.....	\$ 20,230.15		
Appropriated for Special Purposes			
Federal—Hatch Fund.....	\$ 1,540.31		
Federal—Adams Fund.....	1,390.85		
Federal—Purnell Fund.....	5,612.99		
Federal—Bankhead-Jones Fund.....	15,329.08		
State Apprns.—Main Station.....	2,970.10		
State Apprns.—Substations.....	5,854.82		
Sales Funds—Main Station.....	26,839.63		
Sales Funds—Substations.....	31,841.01	91,378.79	\$111,608.94
Current Restricted Funds			
Texas Gulf Sulphur Fund.....	\$ 922.18		
Freeport Sulphur Fund.....	607.76		1,529.94
TOTAL BALANCES, September 1, 1938.....			\$113,138.88

ADD:

Current Research and General Income (Sch. B-1).. \$746,235.60

DEDUCT:

Current Research and General Expenditures

(Sch. B-2)..... \$739,629.40

Unused 1937-38 Leg. Appro. Reverted (Sch. B-1a). 8,824.94 748,454.34

Net Deductions..... 2,218.74

BALANCES, August 31, 1939..... \$110,920.14

Consisting of:

Current Funds—Research and General

(To Exhibit A, Section I-A)

Reserve for Outstanding Orders.....	\$ 1,721.06		
Appropriated for Special Purposes			
Federal—Hatch Fund.....	\$ 1,476.18		
Federal—Adams Fund.....	1,304.18		
Federal—Purnell Fund.....	5,910.50		
Federal—Bankhead-Jones Fund.....	15,874.58		
State Apprns.—Main Station.....	598.17		
State Apprns.—Substations.....	4,817.50		
Sales Funds—Main Station.....	26,049.14		
Sales Funds—Substations.....	45,816.89	101,847.14	103,568.20

Current Restricted Funds

Texas Gulf Sulphur Fund.....	\$ 1,946.78		
Freeport Sulphur Fund.....	728.32		
Cotton Insect Survey Fund.....	1,426.21		
Laboratory Bldg., Angleton (P. W. A.).....	3,250.63		7,351.94

Total, as shown above..... \$110,920.14

SCHEDULE B-1

Statement of Current Income

For the Year Ended August 31, 1939

	Total	Current General Funds	Current Restricted Funds
I. RESEARCH AND GENERAL			
1. Student Fees (None)			
2. Public Appropriations			
a. Federal			
Hatch Act (1881).....	\$ 15,000.00	\$ 15,000.00	
Adams Act (1906).....	15,000.00	15,000.00	
Purnell Act (1925).....	60,000.00	60,000.00	
Bankhead-Jones Act (1935).....	135,361.81	135,361.81	
Total Federal.....	\$225,361.81	\$225,361.81	
b. State Legislative Appropriations (Schedule B-1a and B-1b).....	357,883.00	357,883.00	
Total Public Appropriations.....	\$583,244.81	\$583,244.81	
3. Endowment Income (None)			
4. Gifts and Grants (Schedule B-3).....	\$ 19,268.15		\$ 19,268.15
5. Sales and Services (Schedule B-1c).....	143,356.70	143,356.70	
6. Other Sources			
Interest on Bank Balances.....	365.94	365.94	
Total Research and General (to Exhibit B).....	\$ 746,235.60	\$ 726,967.45	\$ 19,268.15

SCHEDULE B-1a

Summary of State Legislative Appropriations

For Fiscal Year Ended August 31, 1939

	Total	Main Station	Substations
Balances, September 1, 1938, from Appropriations for Previous Year.....	\$ 29,055.07	\$ 3,746.02	\$ 25,309.05
Add Appropriations for Current Year (Sch. B-1b) ..	357,883.00	169,543.00	188,340.00
Total Balances from Previous Year plus Appropriations for Current Year.....	\$ 386,938.07	\$ 173,289.02	\$ 213,649.05
Less Expenditures (Sch. B-2).....	370,976.40	168,114.56	202,861.84
Unexpended Balances.....	\$ 15,961.67	\$ 5,174.46	\$ 10,787.21
Less Reversions to State Treasury from Previous Year Balances (to Exhibit B).....	8,824.94	2,970.12	5,854.82
Balance, August 31, 1939 (to Exhibit A).....	\$ 7,136.73	\$ 2,204.34	\$ 4,932.39

SCHEDULE B-1b

Statement of Current Income from State Legislative Appropriations
(General Revenue)

For the Year Ended August 31, 1939

(Pages 955 to 965, Gen. and Special Laws, 45th Leg. Regular Session)

MAIN STATION:

State Appro.

Number

Y-779	—Salaries.....	\$ 49,597.00	
	Less amount accounted for under Substations	6,435.00	\$ 43,162.00
Y-780	—Administrative.....		14,150.00
Y-781-82	—Veterinary Science.....		2,600.00
Y-783-84	—Horticulture.....		3,450.00
Y-785-86	—Range Animal Husbandry.....		6,380.00
Y-787-90	—Entomology (Including Foul Brood).....		11,126.00
Y-791-92	—Apiculture.....		6,355.00
Y-793-94	—Agronomy.....		3,280.00
Y-795-96	—Main Station Farm.....		4,610.00
Y-797-802	—Plant Pathology.....		6,980.00
Y-803-4	—Soil Survey.....		8,330.00
Y-805-6	—Farm and Ranch Economics.....		5,170.00
Y-807	—Publications.....		5,000.00
Y-808	—Botany.....		250.00
Y-809-15	—Cotton Root Rot Investigations.....		20,725.00
Y-816-17	—Cotton Insect Investigations.....		13,435.00
Y-818-19	—Loco Weed Research.....		6,040.00
Y-820	—Sweet Potato Investigations.....		3,500.00
Y-903	—Grape Investigations.....		5,000.00

Total Main Station..... \$ 169,543.00

SUBSTATIONS:

Y-779	—Salaries (See Main Station).....	\$ 6,435.00
Y-821-27	—No. 1—Beeville.....	11,460.00
Y-828-36	—No. 2—Tyler.....	15,440.00
Y-837-43	—No. 3—Angleton and Plant Lice Laboratory.....	20,960.00
Y-844-46	—No. 4—Beaumont.....	9,310.00
Y-847-49	—No. 5—Temple.....	10,510.00
Y-850-51	—No. 6—Denton.....	5,710.00
Y-852-56	—No. 7—Spur.....	8,700.00
Y-857-61	—No. 8—Lubbock.....	8,950.00
Y-862-63	—No. 9—Balmorhea.....	4,310.00
Y-864-65 & 69	—No. 10—College Station (Feeding and Breeding).....	5,720.00
Y-866 & 870	—Division of Dairy Husbandry.....	2,400.00
Y-867 & 871	—Division of Swine Husbandry.....	4,200.00
Y-868 & 872	—Division of Poultry Husbandry.....	3,700.00
Y-873-81	—No. 11—Nacogdoches.....	18,360.00
Y-882-83	—No. 12—Chillicothe.....	4,310.00
Y-884-88	—No. 14—Sonora.....	13,545.00
Y-889-94	—No. 15—Weslaco (Lower Rio Grande).....	13,805.00
Y-895-97	—No. 16—Iowa Park (Wichita Valley).....	8,350.00
Y-898-902	—No. 19—Winter Haven.....	12,165.00

Total Substations..... \$ 188,340.00

Total State Legislative Appropriations..... \$ 357,883.00

SCHEDULE B-1c

Statement of Current Income from Sales and Services

For the Year Ended August 31, 1939

MAIN STATION:

Administrative.....	\$ 186.17
Veterinary Science.....	1,042.04
Horticulture.....	21.12
Range Animal Husbandry.....	414.58
Entomology.....	42.81
Apiculture.....	112.21
Agronomy.....	4.70
Main Station Farm.....	2,931.79
Plant Pathology.....	172.49
Loco Weed Research.....	196.11
Chemical Analysis.....	18,514.03
Photographic Laboratory.....	3,905.28
Big Spring Cattle Feeding.....	2,956.39
A. H. Feeding Fund.....	635.00
Rural Home Research.....	205.68

Total Main Station.....\$ 31,340.40

SUBSTATIONS:

No. 1 -Beeville.....	\$ 4,521.71
No. 2-Tyler.....	846.36
East Texas Soil Erosion.....	1,130.38
No. 3-Angleton.....	1,241.73
Plant Lice Laboratory.....	143.19
No. 4-Beaumont.....	787.02
No. 5-Temple.....	1,640.42
Temple Soil Erosion.....	6,919.07
No. 6 -Denton.....	5,323.01
No. 7-Spur.....	16,889.09
No. 8-Lubbock.....	4,925.85
No. 9-Balmorhea.....	5,318.81
No. 10-College Station (Feeding and Breeding).....	2,227.74
Division of Dairy Husbandry.....	19,018.24
Division of Swine Husbandry.....	6,818.57
Division of Poultry Husbandry.....	5,876.31
No. 11 -Nacogdoches.....	1,653.28
No. 12 -Chillicothe.....	3,659.82
No. 14 -Sonora.....	8,940.32
No. 15-Weslaco (Lower Rio Grande).....	4,455.31
No. 16-Iowa Park (Wichita Valley).....	2,140.20
No. 19-Winter Haven.....	3,505.01
Amarillo Soil Conservation.....	4,034.83

Total Substations.....\$ 112,016.30

Total Sales and Services.....\$ 143,356.70

TEXAS AGRICULTURAL EXPERIMENT STATION

SCHEDULE B-2
Statement of Current Expenditures
 For the Year Ended August 31, 1939

	FUND DISTRIBUTION				Grand Total	OBJECT CLASSIFICATION			
	CURRENT GENERAL FUNDS					Salaries and Wages	Other Operating Expense	Equipment	Buildings and Other Improvements
	Federal Funds	State Apprsns.	Sales Funds	Total General					
RESEARCH AND GENERAL									
Main Station:									
Administrative.....	\$ 16,697.46	\$ 30,029.31	\$ 1,153.41	\$ 47,880.18	\$ 47,880.18	\$ 32,142.71	\$ 4,565.32	\$ 11,172.15	
Veterinary Science.....	14,651.37	5,815.00	688.49	21,154.86	21,320.32	16,659.18	3,450.39	1,210.75	
Horticulture.....	12,133.16	15,004.13	13.69	27,150.98	27,522.68	18,463.40	2,620.08	752.34	\$ 5,686.86
Range Animal Husbandry.....	20,674.27	11,527.95	6,551.41	38,753.63	38,753.63	27,113.89	5,042.77	3,171.55	*3,425.42
Entomology.....	8,675.51	27,381.88	80.66	36,138.05	37,649.95	31,726.68	5,266.79	656.48	
Apiculture.....		6,355.00	86.63	6,441.63	6,441.63	5,509.00	778.07	154.56	
Agronomy.....	19,122.26	7,780.00	63.92	26,966.18	26,966.18	22,239.96	3,242.52	1,267.33	216.37
Main Station Farm.....		4,610.00	2,214.93	6,824.93	6,824.93	4,805.09	1,327.04	67.80	
Plant Pathology.....	13,121.50	8,628.98	82.61	21,830.09	23,109.66	13,805.19	2,298.54	1,630.23	5,375.70
Soil Survey.....	500.00	8,319.90	339.22	9,159.12	9,159.12	7,568.00	1,065.11	526.01	
Farm and Ranch Economics.....	35,268.52	6,935.00		42,203.52	42,203.52	38,285.99	3,184.40	723.13	
Publications.....	200.00	6,883.00		7,083.00	7,083.00	2,280.00	4,803.00		
Botany.....	1,320.00	1,450.00		2,770.00	2,770.00	2,520.00	238.65	11.35	
Cotton Root Rot Research.....	825.00	20,353.39		21,178.39	21,178.39	16,994.05	843.65	2,626.76	713.93
Loco Weed Research.....		5,694.02		5,694.02	5,694.02	5,303.98	224.42	132.41	92.56
Chemistry.....	20,975.81		79.35	21,055.16	21,055.16	18,463.40	2,620.08	1,210.75	
Photographic Laboratory.....		1,350.00	17,017.43	18,367.43	18,367.43	16,659.18	3,450.39	1,210.75	
Rural Home Research.....	18,624.50		3,994.57	22,619.07	22,619.07	18,463.40	3,759.98	1,405.69	
Agricultural Engineering.....	6,887.42		130.51	7,017.93	7,017.93	6,441.63	1,727.45	418.37	
				6,887.42	6,887.42	16,621.77	1,378.85	754.39	
Total Main Station.....	\$ 189,676.78	\$ 168,114.56	\$ 32,466.83	\$ 390,258.17	\$ 393,616.80	\$ 305,435.62	\$ 46,249.87	\$ 26,420.47	\$ 15,510.84

SCHEDULE B-2—Con't.

Analysis by Sources of Funds and Expense Classes

	DISTRIBUTION BY DIVISIONS		Total	DISTRIBUTION BY EXPENSE CLASSES			
	Main Station	Substations		Salaries and Wages	Other Operating Expense	Equipment	Buildings and Other Improvements
RESEARCH AND GENERAL EXPENDITURES							
Current General Funds							
Federal Funds							
Hatch Fund	\$ 14,319.13	745.00	\$ 15,064.13	\$ 13,642.98	\$ 1,107.85	\$ 313.30	
Adams Fund	14,486.67	600.00	15,086.67	14,937.53	149.14		
Purnell Fund	56,892.49	2,810.00	59,702.49	53,632.53	4,750.00	1,083.59	216.37
Bankhead-Jones Fund	103,978.49	30,837.82	134,816.31	102,488.39	12,448.24	8,133.67	11,741.01
Total Federal Funds	\$ 189,676.78	\$ 34,992.82	\$ 224,669.60	\$ 184,721.43	\$ 18,455.23	\$ 9,535.56	\$ 11,957.38
State Appropriations	\$ 168,114.56	\$ 202,861.84	\$ 370,976.40	\$ 266,473.83	\$ 50,467.13	\$ 23,958.34	\$ 30,077.10
Sales Funds	32,496.83	98,040.42	130,537.25	50,643.20	54,398.65	18,481.56	*7,013.84
Total Current General Funds	\$ 390,288.17	\$ 335,885.08	\$ 726,183.25	\$ 501,838.46	\$ 123,321.01	\$ 51,975.46	\$ 49,048.32
Current Restricted Funds (Sch. B-3)	3,328.63	10,117.52	13,446.15	2,191.64	2,148.77	1,450.42	7,655.32
Total Research and General Expenditures	\$ 393,616.80	\$ 346,012.60	\$ 739,629.40	\$ 504,030.10	\$ 125,469.78	\$ 53,425.88	\$ 56,703.64

*Includes \$3,300.00 for purchase of land.

SCHEDULE B-2a

Statement of Federal Hatch Fund

For the State Fiscal Year Ended August 31, 1939

Balance, September 1, 1938.....	\$ 1,540.31	
Received from United States Treasurer.....	15,000.00	
Balance, September 1, 1938, plus additions.....		\$ 16,540.31
Less Expenditures:		
Personal Services.....	\$ 13,642.98	
Supplies and Materials.....	96.78	
Communication Service.....	4.11	
Travel Expenses.....	797.35	
Equipment.....	313.30	
Buildings and Land.....	209.61	
Total Expenditures.....		15,064.13
Balance, August 31, 1939.....		\$ 1,476.18

NOTE: Income and Expenditures are included in Schedule B-1 and B-2.

SCHEDULE B-2b

Statement of Federal Adams Fund

For the State Fiscal Year Ended August 31, 1939

Balance, September 1, 1938.....	\$ 1,390.85	
Received from United States Treasurer.....	15,000.00	
Balance, September 1, 1938, plus additions.....		\$ 16,390.8
Less Expenditures:		
Personal Services.....	\$ 11,937.53	
Supplies and Materials.....	149.14	
Total Expenditures.....		15,086.67
Balance, August 31, 1939.....		\$ 1,304.18

NOTE: Income and Expenditures are included in Schedule B-1 and B-2.

TEXAS AGRICULTURAL EXPERIMENT STATION

SCHEDULE B-2c

Statement of Federal Purnell Fund

For the State Fiscal Year Ended August 31, 1939

Balance, September 1, 1938.....	\$ 5,612.99	
Received from United States Treasurer.....	60,000.00	
Balance, September 1, 1938, plus additions.....		\$ 65,612.99
Less Expenditures:		
Personal Services.....	\$ 53,652.53	
Supplies and Materials.....	2,305.55	
Communication Service.....	273.12	
Travel Expenses.....	1,221.88	
Transportation of Things.....	67.73	
Printing and Illustrating Publications.....	95	
Heat, Light, Water and Power.....	63.24	
Contingent Expenses.....	19.00	
Equipment.....	1,776.65	
Buildings and Land.....	321.84	
Total Expenditures.....		59,702.49
Balance, August 31, 1939.....		\$ 5,910.50

NOTE: Income and Expenditures are included in Schedule B-1 and B-2.

SCHEDULE B-2d

Statement of Federal Bankhead-Jones Fund

For the State Fiscal Year Ended August 31, 1939

Balance, September 1, 1938.....	\$ 15,329.08	
Received from United States Treasurer.....	135,361.81	
Balance, September 1, 1938, plus additions.....		\$150,690.89
Less Expenditures:		
Personal Services.....	\$102,488.39	
Supplies and Materials.....	8,250.70	
Communication Service.....	138.57	
Travel Expenses.....	3,074.46	
Transportation of Things.....	119.85	
Heat, Light, Water and Power.....	196.44	
Contingent Expenses.....	53.00	
Equipment.....	8,458.98	
Buildings and Land.....	12,035.92	
Total Expenditures.....		\$134,816.31
Balance, August 31, 1939.....		\$ 15,874.58

NOTE: Income and Expenditures are included in Schedule B-1 and B-2.

SCHEDULE B-3
Statement of Current Restricted Funds
For the Year Ended August 31, 1939

	INCOME		EXPENDITURES					Balance Aug. 31, 1939 (Exh. A; B)
	Balance Sept. 1, 1938	Gifts (Sch. B-4)	Total Balance and Additions	Salaries and Wages	Other Operating Expense	Equipment	Buildings and Other Improvements	Total
FOR RESEARCH AND GENERAL PURPOSES								
Texas Gulf Sulphur Fund.....	\$ 922 18 \$	2,900 00 \$	3,822 18 \$	1,045 56 \$	752 82 \$	47 02	.....	\$ 1,875 40
Freepoint Sulphur Fund.....	607 76	2,000 00	2,607 76	837 81	890 63	151 00	.....	1,879 44
Cotton Insect Survey Fund.....		2,000 00	2,000 00	255 17	318 62	.....	.....	1,573 79
Special Fertilizer Fund.....		150 00	150 00	53 10	96 90	.....	.....	150 00
Laboratory Bldg.—Angleton (P. W. A.).....		*12,218 15	12,218 15	.....	59 80	1,252 40	7,655 32	8,967 52
Total Research and General.....	\$ 1,529 94 \$	19,268 15 \$	20,798 09 \$	2,191 64 \$	2,148 77 \$	1,450 42 \$	7,655 32 \$	13,446 15 \$

Add Equipment.....

Total Investment in Plant (Exh. E.).....

*U. S. Government P. W. A. Grant.

\$ 1,450 42

\$ 9,105 74

SCHEDULE B-4
Transactions of Revolving Funds
For the Year Ended August 31, 1939

	CREDITS		EXPENDITURES				Credit Balance Aug. 31, 1939 (Exh. A)
	Credit Balance Sept. 1, 1938	Sales	Total Balance and Additions	Salaries and Wages	Other Operating Expense	Equipment	Total
FOR ORGANIZED RESEARCH							
Wool Scouring Plant.....	\$ 593 90 \$	2,698 76 \$	3,292 56 \$	.....	\$ 2,723 74 \$	98 79 \$	2,822 53 \$
Teacher Retirement System.....	.....	17,081 15	17,081 15	.....	17,081 15	.....	17,081 15
Cattle Feeding Revolving Fund.....	7,572 41	10,971 62	18,544 03	.....	.....	8,939 03	8,939 03
Total Organized Research.....	\$ 8,166 21 \$	30,751 53 \$	38,917 74	.....	\$ 19,804 89 \$	9,037 82 \$	28,842 71 \$

\$ 470 03

\$ 9,605 00

\$ 10,075 03

EXHIBIT E

Summary Statement of Investment in Plant

At August 31, 1939

CARRYING VALUE OF PLANT, SEPTEMBER 1, 1938.		\$1,181,451.03
ADDITIONS DURING 1938-39:		
1. Expended from Plant Funds (None)		
2. Expended from Current General Funds (Sch. B-2).....	\$	101,023.78
3. Expended from Current Restricted Funds (Sch. B-3)...		9,105.74
Total Current General and Current Restricted Funds (Sch. B-2).....	\$	110,129.52
4. Expended from Revolving Funds (Sch. B-4).....		9,037.82
5. Expended from Feed Control Service Funds (Exh. F)...		115.93
6. Adjustments to previously reported values.....		128.11
7. Produced by Division, or Substation.....		41,925.24
8. Gifts.....		3,234.58
Total Additions.....		164,651.20
Carrying Value of Plant, September 1, 1938, plus additions....		\$1,346,102.28
DEDUCT:		
1. Sale of Equipment.....	\$	53,365.14
2. Plant assets worn out, discarded, etc.....		14,106.87
3. Transfers to A. & M. College Inventory.....		11,690.90
Total Deductions.....		79,162.91
VALUE OF PLANT, August 31, 1939, (to Exh. A.).....		\$1,266,939.37
Value of Plant at August 31, 1939, made up as follows:		
Land.....		\$ 294,976.10
Buildings.....	\$	479,804.77
Improvements Other Than Buildings.....		38,877.64
Total Buildings and Other Improvements.....		518,682.41
Equipment.....		453,280.86
Total (to Exhibit A).....		\$1,266,939.37

SCHEDULE E-1

Summary Statement of Inventory Valuation

At August 31, 1939

MAIN STATION:

Administrative.....	\$ 10,333.05
Veterinary Science.....	34,509.43
Horticulture.....	30,094.84
Range Animal Husbandry.....	34,210.20
Entomology.....	18,108.46
Apiculture.....	18,141.10
Agronomy.....	21,129.81
Main Station Farm.....	41,353.43
Plant Pathology and Physiology.....	17,529.64
Soil Survey.....	2,806.59
Farm and Ranch Economics.....	6,929.28
Publications.....	15,570.77
Botany.....	3,474.84
Loco Weed Research.....	3,781.87
Chemistry.....	38,372.16
Photographic Laboratory.....	5,867.29
Agricultural Engineering.....	7,077.82
Rural Home Research.....	21,334.65
Feed Control Service.....	6,401.28

Total Main Station.....	\$ 397,032.51
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SUBSTATIONS:

No. 1—Beeville.....	\$ 37,035.85
No. 2—Tyler.....	40,407.16
No. 3—Angleton.....	57,510.29
Truck Crop Insect Investigations.....	1,283.40
No. 4—Beaumont.....	39,420.14
No. 5—Temple.....	76,626.63
No. 6—Denton.....	34,314.43
No. 7—Spur.....	60,881.61
No. 8—Lubbock.....	38,326.45
No. 9—Balmorhea.....	34,070.12
No. 10—College Station (Feeding and Breeding Station).....	53,195.86
Division of Dairy Husbandry.....	33,967.70
Division of Swine Husbandry.....	25,573.03
Division of Poultry Husbandry.....	19,755.36
No. 11—Nacogdoches.....	46,961.74
No. 12—Chillicothe.....	45,787.46
No. 14—Sonora.....	162,493.88
No. 15—Weslaco (Lower Rio Grande).....	117,720.45
No. 16—Iowa Park (Wichita Valley).....	33,829.73
No. 19—Winter Haven.....	38,410.77
Amarillo Soil Conservation.....	3,755.05

Total Substations.....	\$1,004,327.11
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Total Inventory Valuation.....	\$ 1,401,359.62
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Consisting of:

Supplies and Crops Inventories.....	\$ 134,420.25
Invested in Plant.....	1,266,939.37

\$ 1,401,359.62

EXHIBIT F

Transactions of the Feed Control Service

For the Fiscal Year Ended August 31, 1939

INCOME			
Tag Sales.....	\$	169,718.94	
Total Income.....			\$ 169,718.94
EXPENDITURES			
Salaries and Wages			
Administrative Salaries.....	\$	10,125.00	
Instruction and Research Salaries.....		16,850.00	
Clerical and Stenographic Salaries.....		12,450.00	
Wages.....		4,977.22	44,402.22
Consumable Supplies			
Postage, Stationery and Office Supplies.....	\$	1,865.57	
Tags (Purchased).....		19,022.15	
Other Consumable Supplies.....		157.53	21,045.25
Expense			
Telegraph and Telephone.....	\$	341.38	
Travel.....		10,715.13	
Transportation of Things (Service).....		63.69	
Publications.....		3,310.66	
Heat, Light, Power, Water and Gas.....		2,911.89	
Other Current Expenses (Including Chemical Analysis)		18,639.05	
Refunds.....		385.33	36,367.13
Repairs and Alterations			
Repairs to Buildings.....	\$	1,270.92	
Other Repairs.....		39.15	\$ 1,310.07
Total Salaries and Wages Plus Operating Expenses.....			\$ 103,124.67
Equipment			
Main Office			
Furniture and Office Equipment.....	\$	80.22	
Books.....		20.35	
Other Equipment.....		28.00	
Total Main Office.....	\$	128.57	
Other Divisions			
Division of Administration			
Books.....	\$	17.36	
Total Other Divisions.....		17.36	
Total Equipment.....			145.93
Total Expenditures.....	\$	103,270.60	
Surplus Transferred to A. & M. College.....		66,448.34	
Total Expenditures and Surplus.....	\$	169,718.94	



